ABSTRACT BOOK

CREATE ANNUAL CONFERENCE 2024

APRIL 29-30, 2024

Content

Keynote Speech

Understanding Lunar Gateway Orbit

Alfred Ng

Abstract

The Lunar Gateway will be placed in Near Rectilinear Halo Orbit (NRHO). This presentation will explain to the audience why this is a fascinating choice. The presenter will walk through the audience first in the basics of Keplerian orbits. He will introduce concepts of halo orbit, Lagrangian points, delta-V and station keeping.

Speaker Bio

Alfred Ng obtained his Ph.D. from the University of British Columbia in 1992. He joined the Canadian Space Agency as a Research Scientist the same year and he is currently Deputy Director in the Engineering & Capability Demonstration Directorate. He served for 6 years as the Chair of the International Astronautical Federation Astrodynamics Committee. He is also a member of the International Academy of Astronautics. He previously managed the CSA/CNES Joint Collaboration on Stratospheric Balloon program and he was also the Technical Lead on the Canadian CubeSat Project. He was recently assigned as the Acting Head, Academic Development. He has authored and co-authored 14 journal publications and over 45 conference papers.

The Importance of Incorporating Indigenous Knowledge and Perspectives in Environmental Decision Making

Heather Swan and *Michael Fox*

Abstract

Speakers will touch on a number of topics based on their lived experience in this realm. They will touch on key principles to consider, and trends that are leading beyond collaborative decision making and into Indigenous-led processes.

Speakers Bio

Heather Swan is settler of Irish, German and English descent. She is a highly trusted and compassionate professional with over 20 years of experience, who is dedicated to being an ally and accomplice to Indigenous Peoples. She is the VP of Reconciliation at ICE. Her unique dual training and experience in planning and engineering enables an appreciation of varied viewpoints and consensus building, working tactfully and effectively with multiple and diverse individuals and organizations. Heather has worked on projects across Canada from coast to coast to coast working with and for Indigenous Nations and communities, Federal and Provincial governments, regulators, municipalities, developers, mining companies, and energy generation companies.

Michael is from Weenusk First Nation and is the President/CEO of Indigenous Community Engagement (ICE) – one of Canada's leading national Indigenous firms specializing in community consultation, facilitation/negotiations, capacity building, & social research. ICE's mission is to deliver socio-economic change through reconciliation efforts. Michael brings a wealth of experience in structuring projects and financing for both industry and Indigenous clients. He obtained an honours degree in Political Science with a focus on Aboriginal Law & Resource Development and has an MBA with a specialization in Social Enterprise.

Intellectual property (IP) rights and the value of a strong IP strategy

Andrea Ngo

Abstract

This presentation will explore the basics of the different types of intellectual property (IP) rights and the value of a strong IP strategy, with a particular emphasis on patents. The presentation will cover aspects such as the business and commercial value of patents, when to start thinking about patents, what makes a technology patentable and strategies for preserving IP rights. The presentation will also touch upon frequently asked questions and common misconceptions about patents.

Speaker Bio

Andrea is an intellectual property lawyer and registered patent agent at Bereskin & Parr LLP. She specializes in the preparation, drafting and prosecution of patent applications, helping individuals and companies obtain legal protection for their technologies. She assists businesses operating primarily in high-tech industries, including in the software, AI, telecommunication, medical devices, robotics and electronics spaces. She also works closely with startups to develop IP strategic plans. Prior to becoming a lawyer, Andrea studied electrical engineering.

Smart Textile --- The Future of Healthcare, Fashion, and Wearables but more importantly, women's health, (i.e Fibra inc.)!

Parnian Majd

Abstract

The advent of wearable technology has revolutionized the landscape of personal health monitoring, offering unprecedented insights into various physiological parameters. Fibra ("Feebra") is the future of women’s health! It is a data-driven women's health platform, (patent-pending smart underwear+ an app) to give women personalized/accurate reproductive health data (starting with fertility) in the most automated, non-invasive and hassle-free manner. Fibra has filled four patent applications for their novel technology. This is just the beginning! With their proprietary textile-based sensors and the amount of data we are getting from women's bodies, we will go from fertility (today) to pregnancy detection as soon as possible, to pregnancy monitoring to contraceptives to menopause, to even alerting them if they have been exposed to any reproductive system diseases.

This research introduces a novel application of smart textile technology in the form of smart underwear tailored specifically for women's reproductive health monitoring. The proposed smart underwear integrates fabric-based sensors capable of measuring key biophysical and biochemical parameters. The utilization of fabric-based sensors offers several advantages over traditional wearable sensors, including enhanced comfort, flexibility, and seamless integration into everyday attire. The collected data can be wirelessly transmitted to a companion mobile application, allowing users to track trends, receive personalized insights, and share information with healthcare providers. This research highlights the potential of smart textile technology in empowering women to take proactive control of their reproductive health through continuous, non-invasive monitoring. The smart underwear represents a promising tool for early detection of reproductive health issues, promoting timely interventions, and ultimately improving overall reproductive well-being.

Speaker Bio

Parnian Majd is the Founder and CEO at Fibra inc. and she is a distinguished biomedical engineer with a Bachelor's degree from Toronto Metropolitan University and a Master's from the University of Toronto. Recognized for her exceptional contributions to the technology sector, Parnian received the EY 2022 Women in Tech award, and was nominated for the 2023 DMZ Women of the Year award, and CBC reached out to her for an interview. Holding an Entrepreneurship Certificate from Harvard Business School, she seamlessly integrates technical prowess with strategic acumen. Parnian is a passionate advocate for women's health, reproductive health, and innovation in wearables and smart textiles, evident in her impactful speaking engagements at various conferences. Parnian's career reflects a commitment to technology, entrepreneurship, and fostering diversity in the industry.

Decolonization, Equity, Diversity and Inclusion

Jean-Jacques Rousseau

Speaker Bio

Jean-Jacques Rousseau is a philosopher of science, with a practice in inclusive innovation at the intersection of tech, entrepreneurship and big ideas. He is currently Research Associate at the Centre for Disease Modeling (CDM) at the Department of Mathematics at York University.

A member of the 2023 Task Force on the Future of Pedagogy at York University, Jean-Jacques recently completed three years as Special Advisor on Decolonization, Equity, Diversity and Inclusion (DEDI) in the Office of the Dean at the Schulich School of Business, where he remains as Instructor and Academic Director of the Schulich Business Excellence Academy (SBEA), a virtual summer program that introduces business education to senior Ontario high school students. He is Adjunct Faculty Fellow at the Dahdaleh Institute for Global Health Research and Fellow at the Centre for Research on Latin America and the Caribbean (CERLAC).

After 10 years in the Ontario Public Service and years of work as a consultant, he was recruited for the role of Inaugural Technical Advisor in Innovation, Science and Competitiveness to the President of the Republic of Haïti (2017 - 2019). In 2020, he returned to Canada and completed a postdoctoral fellowship in Explainability & Trust in AI Systems at the Lassonde School of Engineering (2020 - 2022).

Jean-Jacques holds a B.A. in Law and Philosophy from Carleton University, MBA from the Schulich School of Business, and PhD in Philosophy of Science from the Institute for the History and Philosophy of Science & Technology at the University of Toronto.

Are You Ready for an Entrepreneurial Journey?

Moren Lévesque

Speaker Bio

Moren Lévesque is Professor and the CPA Ontario Chair in International Entrepreneurship as well as the Co-Director of Entrepreneurial Studies at York University Schulich School of Business. She is also Honorary Professor at the University of Queensland's Business School. Moren holds a Ph.D. in Management Science from the University of British Columbia and M.Sc., B.Sc. in Mathematics from Université Laval. She has been on the faculty at Université Laval, Carnegie Mellon University, Rensselaer Polytechnic Institute, Humboldt Universität, Case Western Reserve University, and the University of Waterloo as a Canada Research Chair in Innovation & Technical Entrepreneurship.

Her research applies the methodologies of analytical and quantitative disciplines to the study of decision making in new business formation. She is interested in market entry decisions, funding decisions, and firm growth decisions, and the impact of time on these entrepreneurial decisions.

Her work appears in *Entrepreneurship Theory & Practice, European Journal of Operational Research, IEEE Transactions on Engineering Management, Journal of Business Venturing, Journal of Management Studies, Journal of Operations Management, Long Range Planning, Manufacturing & Service Operations Management, Organization Science, Production and Operations Management, Research Policy, Strategic Entrepreneurship Journal and Strategic Management Journal*, among other research outlets.

She has served the Academy of Management's Entrepreneurship Division as a member of its Research Committee and its Midwest Regional Liaison, as well as Chair of its Membership Committee. She has also served for a 5-year term as an officer for the Institute for Operations Research & Management Science (INFORMS) Technology, Innovation Management and Entrepreneurship Section (TIMES), and as a TIMES Honorary Chair. Moren currently also serves as Editor for *Entrepreneurship Theory & Practice*, and she served from 2010 to 2020 as Senior Editor for *Production and Operations Management*, and from 2013 to 2017 as Department Editor for IEEE *Transactions on Engineering Management*. In 2021, she was awarded the Academy of Management Entrepreneurship Division's Dedication to Entrepreneurship Award for innovative and impactful contributions to entrepreneurship scholarship.

Demystifying Fermentation in the Production of Specialty Coffees

Gilberto Vinícius de Melo Pereira

Department of Bioprocess Engineering and Biotechnology, Federal University of Paraná, Curitiba 81531-980, Brazil

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Abstract

Coffee stands as a vital commodity in the global market, serving as a significant export product for numerous developing countries and driving a complex, multi-billion dollar industry. The journey of coffee, from bean to cup, involves intricate processing methods that play a crucial role in shaping its flavor, aroma, and overall quality. The fermentation stage in post-harvest coffee processing holds paramount importance as it significantly influences the final quality and flavor profile of the coffee beans. This crucial step involves the breakdown of sugars and mucilage surrounding the coffee beans, leading to the development of unique aromatic compounds and flavors. Building on the success of traditional fermented foods, the coffee industry has experienced a surge in research on the use of yeast and lactic acid bacteria in coffee bean fermentation. In this lecture, we delve into the intricate process of fermentation in the production of specialty coffees. The consequential impact of selected starter culture on coffee quality is evident through the accumulation of aroma-enhancing compounds, such as esters, higher alcohols, aldehydes, and ketones. In addition, recent protocols involving co-inoculation between distinct yeast groups and lactic acid bacteria have emerged. They exhibit metabolic synergism characteristics, producing coffees with heightened body perception, as well as improved aroma and acidity. From traditional wet and dry processing to emerging technologies such as carbonic maceration and induced fermentation, the use of starter cultures has been pivotal in shaping the trajectory of coffee processing for the foreseeable future.

Keywords: Starter culture; bioreactor; yeast; lactic acid bacteria.

Speaker Bio

Dr. Gilberto Vinícius de Melo Pereira is a professor at the Department of Bioprocess Engineering and Biotechnology of the Federal University of Paraná. Under his leadership, a group of dedicated researchers is delving into diverse projects centered around fermentation processes across multiple domains, such as cocoa, coffee, kefir, alcoholic beverages, functional beverages, vinegar, and indigenous beverages. His research portfolio encompasses a wide array of topics, including microbiome construction and simulation, advanced techniques for analyzing microbial diversity, microorganism selection for biotechnological applications, probiotics, and fermentation process engineering. Dr. Pereira is a permanent professor in the Postgraduate Programs in Bioprocess Engineering and Biotechnology at UFPR and Biotechnology at the Federal Technological University of Paraná (UTFPR). He also coordinates the undergraduate course in Bioprocess Engineering and Biotechnology at UFPR and is recognized as a distinguished Productivity Researcher by the Brazilian Ministry of Science and Technology. His significant contributions to the field are evident through numerous citations in academic databases and his recognition as a leading global researcher by Elsevier in 2023.

Career Compass: Navigating Your Future

Embarking on a new career path can be both exhilarating and daunting. Whether you're considering a switch to a different industry, pursuing a new role, or exploring entrepreneurship, navigating career transitions requires careful planning, resilience, and a willingness to embrace change. Join us for an insightful discussion where seasoned professionals share their personal stories, practical tips, and strategies for successfully transitioning careers.

Prominent Guests

Alessandro Pellerit, BluMetric

Alessandro, master's degree and PhD in chemistry, Environmental Engineer with PEO and Chartered Chemist with ACPO, has 25 years of experience in site assessment and remediation in Canada and Italy. He currently leads the Ontario Environmental Site Assessment and Remediation Team for BluMetric, and volunteers in mentoring and training initiatives for young and international environmental professionals.

Alfred Ng, Canadian Space Agency

Alfred Ng obtained his Ph.D. from the University of British Columbia in 1992. He joined the Canadian Space Agency as the Research Scientist the same year and he is currently Deputy Director in the Engineering & Capability Demonstration Directorate. He served for 6 years as the Chair of the International Astronautical Federation Astrodynamics Committee. He is also a member of the International Academy of Astronautics. He previously managed the CSA/CNES Joint Collaboration on Stratospheric Balloon program and he was also the Technical Lead on Canadian CubeSat Project. He was recently assigned as the Acting Head, Academic Development. He has authored and co-authored 14 journal publications and over 45 conference papers.

Andrew Maxwell, York University

Andrew combines practical experience, award winning research and over thirty years of research and experience in the fields of Innovation Management and Technology Venture Creation, working with diverse enterprises (Fortune 500 companies, and SMEs), with a strong focus on the commercialization of University Research. He regularly runs short workshops, industry workshops and offers a graduate class in technology commercialization (which has been transformed into a global classroom with participation from students at global universities). He has collaborated on over 15 research awards since joining Lassonde in 2014, where his role has been partly training HQPs in the field of technology commercialization, and partly working with PIs, Innovation York and IP Osgoode, to devise the optimum commercialization strategy.

Andrew is on the board of several technology start-ups, and an advisor to industry partners and government organizations on the challenges of creating more innovative organizations, commercializing technology research and scaling up technology ventures for global success.

His current research is on the application of AI tools to innovation, technology commercialization and venture creation educational experiences, AI enabling tools and frameworks he previously developed. In his spare time, he is working alongside Frank Stronach on the creation of a disruptive micromobility electric vehicle – the SARIT.

Andrew White, CHAR Technologies

Andrew, as the Co-founder and CEO of CHAR Technologies, stands at the helm of innovation. Holding a MASc degree in Chemical Engineering from the University of Toronto, he embarked on a transformative journey when a moment of inspirationon in the lab led to the birth of CHAR Tech. His work at CHAR Tech has earned him the OBBA's Young Entrepreneur of the Year award, while his guidance has led the company to be recognized as CIX Top 20 Most Innovative Public Companies.

Gilberto Vinícius de Melo Pereira, Federal University of Paraná, Brazil

Dr. Gilberto Vinícius de Melo Pereira is a professor at the Department of Bioprocess Engineering and Biotechnology of the Federal University of Paraná. Under his leadership, a group of dedicated researchers is delving into diverse projects centered around fermentation processes across multiple domains, such as cocoa, coffee, kefir, alcoholic beverages, functional beverages, vinegar, and indigenous beverages. His research portfolio encompasses a wide array of topics, including microbiome construction and simulation, advanced techniques for analyzing microbial diversity, microorganism selection for biotechnological applications, probiotics, and fermentation process engineering. Dr. Pereira is a permanent professor in the Postgraduate Programs in Bioprocess Engineering and Biotechnology at UFPR and Biotechnology at the Federal Technological University of Paraná (UTFPR). He also coordinates the undergraduate course in Bioprocess Engineering and Biotechnology at UFPR and is recognized as a distinguished Productivity Researcher by the Brazilian Ministry of Science and Technology. His significant contributions to the field are evident through numerous citations in academic databases and his recognition as a leading global researcher by Elsevier in 2023.

Kevin Matthews, Sustainable Resource Solutions Ltd.

Kevin is a businessman with 30 years' experience in developing, build-ing and operating bio-energy facilities. Kevin is the founder and owner of Sustainable Resource Solutions Ltd. (SRS). SRS is focused on identifying and implementing environmental technologies that signifi-cantly reduce and or eliminate Greenhouse Gas emissions. Kevin's activities over the past 30 years have included:

- Founder and CEO of CCI BioEnergy. Kevin established the ap-proach of anaerobic digestion of food waste in North America through CCI. CCI was focused on building and operating both large scale municipal anaerobic digestion plants.
- Past Chairman of the Canadian Biogas Association.
- Guest lecturer to the faculties of Engineering and Business at York University, University of Toronto, MacMaster University.

- Current Chair of Program Management Committee of York University's Collaborative Research and Training Experience Program (CREATE) – Training in Applied Bio-technology for Environmental Sustainability (TABES).

Kevin's expertise lies in:

- Technology License
- Environmental Laws and Regulations
- Corporate and Project Financing
- Corporate Organization and Operations
- Plant Construction and Operations
- Corporate Governance

SMART-ART

Student Presentation Abstracts

SMART-ART

Smart Autonomous Robotic Technology for Space Exploration

https://lassonde.yorku.ca/smart-art/

Characterizing the dielectric properties of icy regolith using Radar through work in the field and in the laboratory in preparation for the future Mars Ice Mapper mission.

Abigail Lee, PhD student, York University

The discussion of liquid water on the Martian surface and subsurface is one which has been around for many years. Recently, the focus has turned to the subsurface and multiple Martian missions have detected candidates for either liquid or solid water. MARSIS could detect a contrast in brightness between the surface and subsurface at the South Polar Layered Deposits. This contrast implies a change in the dielectric properties and suggests the presence of an unfrozen water-saturated sediment, or smectite clay. Using a Martian simulant, this smectite clay can be simulated in the lab and the dielectric properties can be investigated within the same conditions as on Mars by using a chamber. Smectites can absorb vast amounts of water, so experiments at different hydration states are done to explore whether these values could be achieved on Mars, and this will determine the presence of this water-saturate sediment.

Optimal Path Planning and Control for Autonomous Robotic Space Debris Removal Using Artificial Intelligence

Ahmad Al Ali, PhD student, York University

Oral Presentation

Space robotics play a crucial role in on-orbit servicing (OOS) missions and debris removal. However, they must operate with utmost accuracy to achieve target capture. One significant challenge in free-floating robotic capture missions is the disturbance caused by the base spacecraft's motion due to dynamic coupling with the robotic arm, posing high risks. To mitigate this, artificial intelligence is proposed for robotic motion planning. Employing deep reinforcement learning, the path planning strategy for free-floating space manipulators is developed. This solution enables the system to reach and maintain target positions despite high dynamic coupling between the base and arm, enhancing mission safety and reliability. Additionally, a comparison of results stemming from distinct reward functions highlights the efficacy of this AI-driven approach.

The Effect of Microgravity on the Material and Mechanical Properties of ABS Samples, Additively Manufactured via Fused Filament Fabrication

Angela Huang, Master's student, York University

Oral Presentation

In-orbit additive manufacturing (AM) overcomes space and weight constraints of launch vehicles, enhancing space structure design capabilities. Fused Deposition Modelling (FDM) in microgravity is currently known to be feasible and employs filament materials. Key influences on FDM include surface tension of molten droplets, gravity, and atmospheric conditions, impacting dimensional accuracy and mechanical properties of structures. This study assesses gravity's effect on interlayer fusion and mechanical properties by printing test specimens in orientations from 0 (simulating zero gravity) to 90 degrees (similar to Earth's gravity), at 15-degree intervals, using a constant raster angle of 90 degrees. Through tensile and compression testing of specimens, the research highlights how gravity variations affect ultimate strength, elongation, and compressive modulus, without altering surface roughness. These insights aid in optimizing 3D printing for space-based applications, particularly focusing on mechanical performance under different gravitational conditions.

Co-ordinated Multi-Rover Control

Antonia Hoffman, Master's student, Toronto Metropolitan University

Poster and Oral Presentation

Optimal trajectory planning with Active SLAM for damage detection and classification using rovers and small free flying robots. This form of simultaneous localization and mapping allows the robots to plan their trajectories from the maps they generate of their surroundings. They will autonomously detect and classify damage to larger structures. Sensors will include laser range finding (LiDAR) and a vision system. Some sensors will be mounted on the end effector of a 6DOF manipulator. The algorithms and neural networks developed for on-orbit damage classification will be tested on a frictionless planar testbed. The experiments for terrestrial missions will be tested on a customized mobile platform. Simulations of the full experiments will be performed using ROS2 and Gazebo.

Adapting to Inaccurate Observation Data with SAC-Based Path-Planning Control of Gripper in Micro-Gravity

Bahador Beigomi, PhD student, York University

Oral Presentation

Our research introduces a cutting-edge path-planning strategy for robotic manipulation in space, focusing on grasping free-floating objects in micro-gravity. The unpredictability of such environments poses a significant challenge, addressed by our Soft Actor-Critic (SAC) algorithm-driven agent. This agent adeptly adjusts its behavior to precisely position and orient a robotic gripper relative to moving targets. Trained in a simulated environment with variable conditions, the agent learns to navigate and adjust its trajectory for effective target capture, emphasizing precision and adaptability. Despite the introduction of Gaussian noise to simulate sensor inaccuracies, the agent demonstrates robust performance, maintaining high success rates. This advancement highlights the potential of our SAC-based agent in realistic scenarios, offering significant contributions to robotic manipulation in micro-gravity environments. Our findings underscore the agent's sophisticated path-planning and adaptive capabilities, promising for real-world applications.

UAV Autonomous Navigation and De-confliction Powered by Deep Reinforcement Learning

Bingze Xia, PhD student, Concordia University

Oral Presentation

This research discusses the multi-target tracking and obstacle avoidance problem by intelligent quadrotors. It introduces a novel hybrid control scheme that integrates Deep Reinforcement Learning (DRL) and fuzzy logic (FL). By developing new algorithms and modularizing each component of the system, the study addresses several challenges associated with multi-target cases, including policy non-convergence, infinite state space, and agent confusion. This hybrid approach not only enhances the system's adaptability to dynamic and unknown environments but also provides a new toolkit for Reinforcement Learning (RL) applications in such contexts. The hybrid control scheme's combination of DRL and fuzzy logic offers a robust solution to the complexities of navigating and tracking multiple targets simultaneously, paving the way for more efficient and intelligent unmanned aerial vehicles (UAVs) in complex environments.

Shape Reconstruction of an Unknown Target in Orbit using a Swarm of Spacecraft

El Ghali ASRI, PhD student, York University

Oral Presentation

Advances in space technology are leading the industry towards a new age of exploration and industrialization. In this context, space robotics have seen substantial development lately and have been considered for a wide variety of on-orbit servicing tasks such as assembly and debris removal. In this research, it is proposed to use swarm robotics to achieve the task of collectively inspecting an unknown uncooperative target rigid body using multiple spacecraft. The contributions are the design of a “factor graph”-based estimation scheme for mapping a target in space and reconstructing its shape from observations of surface feature points.

Rigid-Flexible Multibody Dynamics and Vibration Suppression for Extra-Large Structures in In-Orbit Additive Manufacturing

Fuzhen Yao, PhD student, York University

Oral Presentation

In the emerging field of in-orbit manufacturing (IOM), spacecraft and structures are constructed in space using additive manufacturing (AM), or 3D printing, utilizing on-site materials or carried resources. This technology offers significant advantages including space-saving, zero gravity construction, and on-site resourcing, enabling the creation of large structures previously deemed impossible due to launch constraints. However, dynamic challenges arise in maintaining precision and stability during the printing process, especially for extra-large, free-floating space structures. This thesis aims to address these challenges by developing high-fidelity models of variable-structure IOM systems, implementing vibration suppression techniques, and conducting path planning for the printer's nozzle to minimize vibration excitation. Through these efforts, the research seeks to advance the feasibility and efficiency of in-orbit manufacturing processes, paving the way for transformative space applications and new business opportunities.

From Creation to Discrimination: Exploiting Self-Supervision in Generative Models for Downstream Discriminative Tasks

Hamidreza Dastmalchi, PhD student, York University

Oral Presentation

Recent advancements in deep generative models, including GANs and Diffusion Models for image generation, GPT models for text, and WaveNet for audio synthesis, have predominantly focused on content creation. These models excel at generating new samples for uses like data augmentation and content generation. Yet, their potential for enhancing discriminative tasks, such as classification has been less explored. This presentation investigates how the generative models can be leveraged for tasks beyond generation. We explore self-supervised learning strategies within these models to improve efficiency and accuracy in classification tasks. Our findings reveal new avenues for applying generative models, demonstrating a paradigm shift in their application towards augmenting discriminative task performance across various domains.

Grid Cell Detection of Dandelion Weed Centers via Convolutional Neural Network

Ibrahim Babiker, PhD student, Concordia University

Poster and Oral Presentation

Within the domain of industrial agriculture, automated weeding uses techniques in Computer Vision and Image Processing to distinguish between crop and weed. Datasets labeling plant centers for mechanical removal are scarce and those that contain grass as the background favour chemical spraying. Furthermore, object detection focuses on Bounding Box and Segmentation tasks which do not predict plant centers. Also, end-to-end methods where model parameters are learnable from input to output are underdeveloped. The presented research develops algorithms to detect dandelion weed plant centers within grass. Locating the center of the plant facilitates eventual mechanical removal. Our research applies several state-of-the-art techniques in Deep learning. We develop a region-based approach that uses alternative labeling. This technique is later expanded in other work to be near end-to-end trainable. Analogously, we test Image Segmentation methods. We intend to further refine and expand these techniques and to explore the use of Synthetic Data.

Navigating Accessibility in Clinical Law Programs for Students with Disabilities

Katie MacEntee, Post Doctoral Fellow, York University

Oral Presentation

The number of individuals with disabilities entering law schools in Canada is on the rise. These students have a fundamental human right to access reasonable accommodations that facilitate their full and active participation in their learning. Clinical legal education programs, which offer hands-on legal training outside the classroom, are competitive experiential education opportunities for law students, including those with disabilities. The research study, Access to and within clinical legal education: The accommodation of law students with disabilities in Ontario, engages students with disabilities and clinical legal educators to investigate the ableist barriers confronted by law students with disability in clinical legal education programs at two law schools in Ontario. This presentation will focus on the experiences of students with disabilities regarding institutional and social barriers to participation in clinical programs. Students use various means and strategies to manage their accommodation needs in clinical settings, sometimes at the expense to their health.

De-spin Massive Asteroids with Miniature Tethered Tugs using Geometric Mechanics and Passivity-Based Control

Mani Kakavand, Post Doctoral Fellow, York University

Oral Presentation

Our presentation introduces a theoretical framework in geometric mechanics, designed for de-spinning massive asteroids by deploying tethered tugs in a heliocentric orbit during the post-capture phase of an asteroid redirection mission. The approach employs Lie Group theory to formulate the Hamiltonian for the tethered tug-asteroid system. Subsequently, a discrete-time Lie Group Hamiltonian integrator is derived based on the Type II d'Alembert variational principle. This is instrumental in developing energy-shaping and passivity-based control laws to achieve control objectives. However, the system is severely ill-conditioned due to the substantial mass disparity between the asteroid and the tug, coupled with the weak gravity gradient between them. To avoid the potential divergence in numerical integration, the symplectic partitioned Runge-Kutta method is used. The proposed framework is applied to the de-spinning asteroid operations at both one astronomical unit and within the asteroid belt at three astronomical units from the Sun.

Multiphysics Simulation of Wire-Fed Laser Metal Deposition in Space Additive Manufacturing

Mitra Taghizadeh, PhD student, York University

The advent of 3D printing in space environments heralds a transformative era in extraterrestrial manufacturing, essential for advancing space exploration and habitation. This study focuses on additive manufacturing in space, particularly laser metal deposition (LMD) with wire feeding, under unique space conditions like zero gravity and vacuum. Unlike Earth-based LMD, where gravity and atmospheric pressure are constant, space-based LMD considers these variables crucially. Using COMSOL Multiphysics, we simulate LMD in space, analyzing zero gravity and vacuum's effects on 3D printing processes, including phase changes, material addition, and thermal dynamics.

Our research identifies optimal LMD parameters for space, such as temperature control, material flow, and laser intensity, vital for achieving quality metal deposition. Post-simulation, Earth-based experiments will validate our findings, providing insights for terrestrial application adjustments. This study's significance lies in its contribution to fabricating and repairing spacecraft components in space, enhancing mission sustainability and autonomy, and paving the way for future advanced manufacturing in space exploration.

In-Situ Skin Bioprinting Techniques

Muhammad Salman Chaudhry, PhD student, York University

Bioprinting and skin tissue engineering stand at a pivotal threshold, necessitating a leap forward to realize its transformative potential. This study explores the integration of computational models, autonomous robotics, and customized biomaterials as key enablers for successfully navigating the complex anatomical landscape of the human body in bioprinting applications. It introduces a novel in-situ bioprinting approach, designed to precisely deposit biomaterials on unconventional and foreign targets/platforms. Central to this study is the development of an interconnected system that integrates (i) a geometric modeling procedure to generate a free-form/planar toolpath that enables printing on anatomical models, (ii) an autonomous tracking and control algorithm to respond to unprecedented motions of the printing platform, and (iii) a composite hydrogel formulation optimized for the direct extrusion printing process.

Empirical studies demonstrated that the slicing algorithm enhanced bioprinting adaptability and accuracy on free-form surfaces. Two slicing methodologies are proposed to effectively model multi-layered heterogeneous skin implants: top-down and bottom-up approaches. Both approaches leverage the implant interface's surface geometry, mitigating the staircase effect and providing control over interlayer interactions. This advancement is crucial for accurately replicating the structural complexity of skin implants.

Based on real-time visual feedback, the developed asynchronous adaptive tracking and printer control system demonstrated a capability to sustain print quality on substrates moving at speeds of up to 50 mm/min while managing speeds of up to 2500 mm/min. This is achieved by developing a framework for parallel execution of high-level tracking and low-level control algorithms, along with strategic switching between printing and tracking modes. This marks the first instance of successful printing on moving platforms and real-time guidance of the in-situ printing process.

The optimized GelMA/CNF composite biomaterial exhibited enhanced mechanical and rheological properties, indicating its suitability for skin bioprinting applications. Characterizing GelMA's transition temperature sensitivity to heating and cooling rates also facilitated its adaption for the direct extrusion printing process.

In-situ bioprinting technology offers great promise, but the challenges involved are multifaceted and must be addressed to achieve its full potential. While previous works focused on either hardware innovation or bioink development, this dissertation bridges these domains, offering a comprehensive approach to the challenges of in-situ bioprinting. Objectives in this dissertation are addressed by an interdisciplinary approach, representing incremental advancements needed further to develop the in-situ bioprinting technology for the skin. The research presented herein sets the stage for realizing true bioprinting potential—that extends into revolutionizing wound healing, bioprinting, and the broader field of additive manufacturing.

Design and implement a fully autonomous robot for weed removal using a mechanical actuator

Nishanth Rajkumar, Master's student, Concordia University

Oral Presentation

In this project, a complete structure has been formulated to design and implement a fully
autonomous robot for weed removal using a mechanical actuator. The robot will be equipped
with a camera for feedback, which will be used to align the actuator with the weed.

The overall control scheme will involve a closed-loop system, where the error between the desired position of the actuator and the actual position will be fed into the PID controller. The PID controller will then output a control signal to the actuator, which will adjust its position accordingly. The camera will continuously monitor the position of the weed and provide feedback to the control system.

Overall, the proposed design and control system aims to provide a robust and efficient solution for autonomous weed removal, which can significantly reduce the time and effort required for manual weed removal.

Nodal Position Finite Element Method of Hexahedral Isoparametric Elements with Incompatible Modes

Qi Zhang, PhD student, York University

Oral Presentation

This paper presents a novel nodal position finite element method (NPFEM) as an alternative to the existing finite element method (FEM) for real three-dimensional problems. The NPFEM adeptly addresses the limitations commonly encountered in traditional FEMs, especially in dynamic scenarios characterized by significant rigid motion combined with elastic deformation. Distinctively, our method utilizes hexahedral isoparametric elements with incompatible modes and nodal positions as basic variables to derive the nonlinear stiffness matrix and inertial forces based on the continuum mechanics theory. Theoretical analysis indicates that the NPFEM effectively reduces the error accumulation often existing in conventional FEMs, particularly in long-term computations involving nodal displacements. Numerical simulation results demonstrate the NPFEM's superiority over traditional methods, evidenced by its enhanced accuracy, reduced error propagation, and improved integration capabilities. The successful implementation of the NPFEM in complex simulations underlines its potential to provide significant advancements in computational mechanics, offering new perspectives and methodologies in this field.

Computational Control of Elastodynamic Systems using Control Lyapunov Functions

Zhengze Liu, PhD student, York University

Oral Presentation

The Finite Element Method (FEM) has revolutionized numerical methods for analyzing elastic system dynamics. Despite its widespread adoption, a notable gap exists in accessible computational control methods tailored for dynamic systems governed by elasticity. This presentation aims to bridge this gap by laying the foundation for a systematic approach to designing stabilizing control mechanisms for flexible body dynamic systems. Expanding upon Sontag's formula for FEM systems, the proposed method offers a framework to tackle the challenges of controlling elastic systems. Its unique advantage lies in simplifying controller design while effectively managing the complexities of flexible body dynamics. Furthermore, the presentation advocates leveraging the inverse optimal property to enhance the proposed controller's effectiveness. Through these strategies, this research endeavors to enhance the accessibility and efficacy of control methods for elastic system dynamics.

TABES

Student Presentation Abstracts

https://lassonde.yorku.ca/tabes/

Landfill leachate treatment using a combination of biological and electrochemical methods

Anusha. Atmakuri, PhD student, Institut national de la recherche scientifique

Poster Presentation

Landfilling is a common method for solid waste disposal, resulting in the formation of landfill leachate (LFL) containing various contaminants. This study investigates the combined use of biological and electrochemical methods, specifically extracellular polymeric substances (EPS) and electrocoagulation (EC), for LFL treatment. EPS, produced from waste substrates like activated sludge and crude glycerol, is employed as a bioflocculant in conjunction with EC. The coupling of EC with EPS as pre or post-treatment offers an efficient and economical approach to decontaminate LFL contaminated with suspended matter, metals, and ammonical nitrogen. Comparative analyses demonstrate the effectiveness of using crude EPS as a bioflocculant, with higher concentrations achieved through specific production methods. Additionally, the study evaluates different treatment scenarios, highlighting the potential of combined EPS and EC approaches for comprehensive pollutant removal from LFL. Preliminary results indicate successful removal of major pollutants such as COD, turbidity, and total suspended solids, emphasizing the need for further exploration to optimize treatment efficiency.

Enzymatic biodegradation of BTEX

Diego Alejandro Hernandez, Master's student, York University

Oral Presentation

To date, 25% of the Canadian population depend on groundwater for daily water use. However, the dynamic economy and the rising demand of petroleum hydrocarbons lead to an increase in the levels of high-risk pollutants such as Benzene-Toluene-Ethylbenzen-Xylene (BTEX). These chemicals are widely reported for their carcinogenic nature. The aim of this study is to assess the potential of a co-culture between S. fonticola and M. esteraromaticum to degrade BTEX compounds. The two strains were inoculated (1:1 ratio) in serum bottles containing Tryptic soy broth media supplemented with 200 mg/L of BTEX and 50 mg/L of each single compound. All experiments were done in triplicates to check the reproducibility. Results suggested that the bacterial co-culture has a superior ability to degrade single benzene (99%) and single toluene (71%) when compared to the individual strains for 42 hours. Likewise, co-culture showed a higher BTEX simultaneous removal (47%), which is better than the achieved by S. fonticola (42%) and M. esteraromaticum (45%) within the same period. Co-culture is a prospect for further studies on the production of BTEX-degrading enzymes that could be a promising and sustainable solution for the on-site degradation of BTEX.

Elaboration, modeling of the durability of a wood -composite

Elloumi Mohamed Yassine, Master's student, Université du Québec en Abitibi-Témiscamingue

Poster Presentation

Environmental and economic concerns have led to a considerable growth of sustainable materials from bio-based plastics. The question of sustainability prevents bio composites from positioning themselves as competitors of traditional products. However, even if many works focus on bio composites, few simultaneously explore the thermomechanical aspect of bioplastic reinforced with a high fiber content. This study aims to develop and characterize the sustainability of bio-composites with high bio-based content for advanced applications. Together, cumulative waste from paper mills poses a pollution and management problem in North America. For this purpose, two types of fibres from different paper processes (chemical (kraft) and thermomechanical (TMP)) were used as reinforcement with different concentrations (40, 50 and 60% by weight). In addition, an acetate matrix was used to increase the biobased content. A HDPE matrix was chosen as the reference. Tests such as infrared spectroscopy (FTIR), differential scanning calorimetry (DSC), rheological tests, thermogravimetric analysis (TGA), dimensional stability, and mechanical analysis will be performed for the determination of physical properties, rheological and mechanical bio composites. Short creep tests will be performed at different temperatures. Two popular creep models, the four-element Burgers model and the Findley power law model will be used to adjust the measured creep data. Then the parameters of these models will be identified. In a second step, a time-temperature superposition principle (TTS) will be attempted for the prediction of long-term creep and the construction of the master curve.

How Citizen Science, Open Access Shared Data, and Truth and Reconciliation are Linked to the Emerging Biodiversity Market

Julia Bava, Master's student, York University

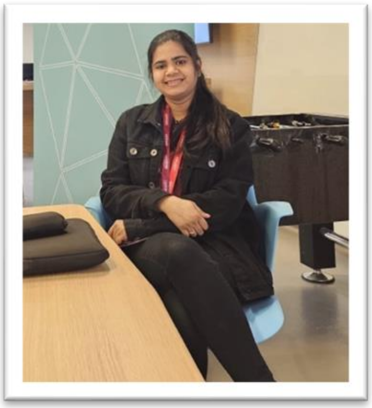
Poster and Oral Presentation

Sustainable, nature-based solutions for waste valorization require financial supports that reach beyond government grants. The Conservation Impact Bond (CIB) is an emerging environmental finance tool aimed at incentivizing conservation work. Through the creation of such tools, citizen science initiatives are funded. The In The Zone Tracker program is a citizen science approach that monitors gardening projects and encourages wise landscape practices - in line with traditional Indigenous knowledge - that generate a net increase in biodiversity.
This research aims to: 1) Assess ecological blind spots in Southwestern Ontario, 2) Understand the public's perception of the Conservation Impact Bond, 3) Determine if the In The Zone program supports the hypothesis that planting native plant species increases the biodiversity dividend, and 4) Discuss the challenges and successes of collecting open access citizen science data. Commercialization of nature-based solutions via social enterprises offers existing ecosystem services as a mechanism for mitigating climate change.

Unlocking Potential of Efficient Xylose Utilization in Rhodosporidium toruloides

Lachi Wankhede, PhD student, York University

Oral Presentation



Addressing the need for sustainable energy, biofuels present a renewable, potentially carbon-neutral option. Oleaginous yeasts like Rhodosporidium toruloides are key for biofuel production due to their high lipid content and versatility in metabolizing various substrates while tolerating toxic compounds. Despite its potential, R. toruloides faces limitations due to suboptimal xylose uptake. This study focused on enhancing the xylose uptake efficiency of R. toruloides-1588 through adaptive laboratory evolution (ALE) across 13 generations in minimal media containing 10 g/L xylose. The evolved strain showed an 80% increase in the xylose consumption rate, with complete xylose assimilation and about a 30% increase in biomass within 16 h compared to the native strain. This advancement highlighted ALE's role in enhancing microbial strains for biofuel production and pioneering efficient lignocellulosic biomass use, leading to more sustainable and cost-effective methods. Further research on genetic changes through genome sequencing and proteomics will clarify xylose utilization improvements, guiding future bioengineering in the biofuel sector.

Cellulose-based 3D-printed materials for electrical insulation applications

Morgan Lecoublet, PhD student, Université du Québec en Abitibi-Témiscamingue

Poster and Oral Presentation

Landfill leachate is a complex wastewater containing high concentration of pollutants such as COD 140-152000 mg/L, ammonia nitrogen 50-2200 mg/L and phosphorus 0.5-485 mg/L that contaminate entire aquifer if not properly managed. To meet the guidelines for effluent discharge, several technologies are currently used to treat landfill leachate. Over the last three decades, membrane bioreactor (MBR) has emerged as a promising method for the treatment of landfill leachate. However, several studies confirmed that MBRs are associated with high-cost requirements resulting from membrane fouling, aeration, excess sludge management, and removal of phosphorus and heavy metals. To mitigate the challenges, the integration of electrochemical processes with MBR has been proposed in recent studies. This project aims to study the potential of an integrated system, membrane bioreactor (MBR) technology and electro-coagulation (EC) in a single unit process for treating real landfill leachate effluent. Current experiments aim to evaluate the contribution of electro-coagulation in the integrated electro-MBR (eMBR) by evaluating performances of eMBR for conventional contaminants removal and membrane fouling. Moreover, dynamics of microbial communities and their effects on eMBR's pollutants removal under varying operating conditions of solid retention time (SRT) and hydraulic retention time (HRT) will be studied.

Direct Fluorescence and Spectrophotometric-based Detection of Azithromycin Using Fluorescein Isothiocyanate: Method Development and Comparative Analysis

Noha Hasaneen, Master's student, York University

Oral Presentation

Azithromycin, a widely used antibiotic, presents environmental concerns due to its presence in soil and water, contributing to antimicrobial resistance. Approximately 6-14% is excreted unchanged in urine, which is sometimes used as fertilizer. To prevent soil pollution, monitoring azithromycin levels in urine is crucial. Novel fluorescence and spectrophotometric techniques, utilizing fluorescein isothiocyanate (FITC), were developed for azithromycin analysis. Its ion pair complex with FITC enhanced fluorescence at 520 nm and absorbance at 480 nm. The fluorescence method offered superior sensitivity and precision over spectrophotometry. It provided a linear range of 0-31.25 µg/ml, with a detection limit of 0.41 µg/ml and a quantification limit of 1.23 µg/ml. In contrast, spectrophotometry had higher detection and quantification limits. Moreover, the fluorescence method showed better recovery in artificial urine samples, indicating enhanced precision in complex matrices. These techniques promise rapid and sensitive azithromycin analysis, applicable in diverse matrices such as biological samples post-extraction.

Electro-Membrane bioreactor integrated process for the treatment of landfill leachate

Oumaima El Hachimi, PhD student, Institut national de la recherche scientifique

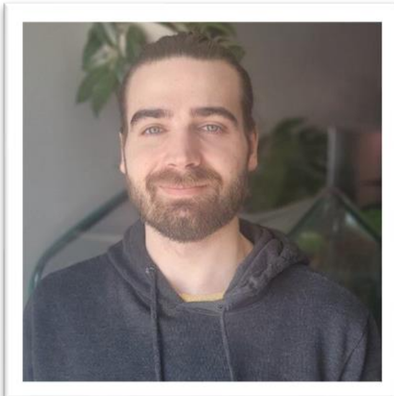
Oral Presentation

Landfill leachate is a complex wastewater containing high concentration of pollutants such as COD 140-152000 mg/L, ammonia nitrogen 50-2200 mg/L and phosphorus 0.5-485 mg/L that contaminate entire aquifer if not properly managed. To meet the guidelines for effluent discharge, several technologies are currently used to treat landfill leachate. Over the last three decades, membrane bioreactor (MBR) has emerged as a promising method for the treatment of landfill leachate. However, several studies confirmed that MBRs are associated with high-cost requirements resulting from membrane fouling, aeration, excess sludge management, and removal of phosphorus and heavy metals. To mitigate the challenges, the integration of electrochemical processes with MBR has been proposed in recent studies. This project aims to study the potential of an integrated system, membrane bioreactor (MBR) technology and electro-coagulation (EC) in a single unit process for treating real landfill leachate effluent. Current experiments aim to evaluate the contribution of electro-coagulation in the integrated electro-MBR (eMBR) by evaluating performances of eMBR for conventional contaminants removal and membrane fouling. Moreover, dynamics of microbial communities and their effects on eMBR's pollutants removal under varying operating conditions of solid retention time (SRT) and hydraulic retention time (HRT) will be studied.

Epoxidized Canola Oil as an Environmentally Friendly Compatibilizer for Blending Poly(Lactic Acid) and Poly(Butylene Adipate-co-Terephthalate)

Quintin Litke, PhD student, University of Manitoba

Oral Presentation



Nearly 20% of food produced in Canada is wasted, accounting for $50 billion in annual losses. Furthermore, food poisoning affects 1 in 8 Canadians each year, resulting in 11,632 hospitalizations and 234 deaths. Food packaging contributes to the 370 million metric tons of plastic produced each year, of which about 50 million tons reaches the environment. Therefore, there is an imminent need for novel food packaging which addresses the issues of food waste and plastic pollution. This research aims to reduce this food waste and plastic pollution by developing active and intelligent food packaging from biodegradable materials and natural, functional additives. Recent efforts have been focused on producing of nanofibrous membranes containing Brazilin, a polyphenol flavonoid with antioxidant and antimicrobial activity to delay spoilage, along with a colorimetric response to changes in pH to sense spoilage. Additionally, work has been done on the measurement of food spoilage in Arctic Char.

Thermal-alkaline pre-treatment of food waste to produce volatile fatty acids through fermentation

Reema, PhD student, York University

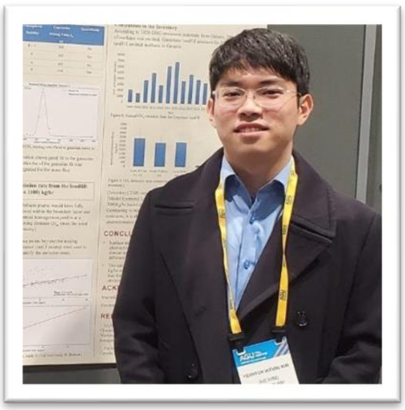
Oral Presentation

Performing food waste fermentation at mesophilic or thermophilic temperatures in colder countries is energy-intensive when the average temperatures remain under psychrophilic ranges for most of the year. The production of VFAs under the psychrophilic temperature of 17°C in comparison to the mesophilic temperature of 37°C after thermal-alkaline pretreatment of the substrate enhances hydrolysis. In this study, with pretreatment at 120°C and pH 9, there was a 2-fold increase with 2 g/L of total VFAs under psychrophilic temperature and acetic acid was the major constituent. The psychrophilic temperature conditions also show a minimal generation of propionic acid as opposed to that usually observed in digestion studies, thus reducing its inhibitory effects on the system. This study of using substrate pretreatment to enhance hydrolysis and acidogenesis at psychrophilic temperature resulted in a less complex VFA mixture with acetic acid as the major constituent. More acetic acid and electron donor accumulation can thus promote chain elongation to produce long-chain VFAs.

Enhancing photocatalysts efficiency by heterostructure design and its electrochemical characterization

Yeuhyun (Kevin) Kim, PhD student, York University

Oral Presentation



In recent decades, the fabrication of various photocatalytic nanomaterials has become a significant area of research due to their application in environmental remediation. Despite its potential, real-world applications face challenges such as poor photocatalytic efficiency and limited light absorption. Therefore, heterostructure photocatalysts has attracted considerable attention for its demonstrated potential in achieving efficient charge separation, leading to improved photocatalytic activity in degrading organic pollutants. These structures achieve spatial charge carrier separation via built-in electric fields at semiconductor interfaces, optimizing redox potential. The presentation will discuss synthesizing and bandgap engineering nanocomposites materials to facilitate the shift from Type-II to Z-scheme electron flow. Electrochemical measurements confirm and provide comprehensive understanding of photogenerated charge carrier dynamics, interface properties and electron transport mechanisms under dark and varying illumination conditions to offer insights into optimizing the Z-scheme architecture materials.

Hygrothermal effects on adhesively bonded CFRP-to-concrete systems

Zahir Namourah, PhD student, Université du Québec en Abitibi-Témiscamingue

Poster and Oral Presentation

The use of fibre-reinforced polymer materials for strengthening existing structures has been increasing as an alternative to traditional materials due to their superior durability, lightweight, low maintenance cost, and rapid installation. Adhesive bonding techniques such as near-surface mounted (NSM) and externally bonded reinforcement (EBR) are preferable. Despite the increasing knowledge, the long-term performance of these strengthening techniques is still not clearly understood, limiting their use. This work aims to provide reliable predictions of the long-term performance of these techniques supported by numerical modelling and calibrated with the experimental program developed in this work. Carried out work includes i) preparing the constituent materials, ii) building NSM and EBR systems, and iii) performing the mechanical characterizations at the pre-ageing stage. Future work will include i) applying ageing conditions, ii) performing mechanical, morphological, and chemical characterizations, and iii) conducting numerical analysis to provide long-term prediction.

MTA

Student Presentation Abstracts

Microsystems Technologies & Application

Low-cost Ion-selective polymer (ISP) membrane - Integrated Electrochemical Microsensor for Low-limit Water Salinity Monitoring

Ayobami Elisha Oseyemi, PhD student, York University

Poster and Oral Presentation

Rapid, inexpensive, and precise water salinity testing remains indispensable in drinking water quality monitoring applications. This study presents a novel electrochemical microsensor featuring a UV-curable Ion-Selective Polymer (ISP) membrane within a microfluidic chip for sensitive detection of salt ions. Utilizing carboxylic and amide groups for ion selectivity, the sensor demonstrates enhanced sensitivity and specificity through chronoamperometry, accurately detecting NaCl levels from 0 - 800 part-per-million (ppm). The integration of the ISP membrane significantly improves detection capabilities, lowering the Limit of Detection (LOD) from 0.25 ppm to 0.14 ppm and the Limit of Quantification (LOQ) from 0.95 ppm to 0.16 ppm, while increasing sensitivity. This advancement marks a significant step towards effective low-cost point-of-need water quality monitoring.

Athermal Design for Optical Phased Arrays

Constantine Papakonstantinou, Master's student, York University

Poster and Oral Presentation

Optical phased arrays (OPA) are of growing interest in free space communication systems due to the need for high speed communication. Generally, design of OPA's will rely on the thermo-optic effect to tune the refractive index, thereby controlling the phase in each channel. However this makes the design sensitive to parasitic heat. Thermal tolerance is introduced by reducing thermo-optic effect, and leveraging the electro-optic effect in lieu. Techniques for athermal design are discussed. The design of compact grating antennas suitable for dense array configurations is explored. The design of such antennas also benefeit from athermal design, due to enhanced bandwidth.

Optical phased array system implementation

Ilyas Kandid, Master's student, Carleton University

Poster and Oral Presentation

Optical phased arrays (OPAs) are an emerging technology that enables solid state beam steering on chip. They are currently marketed for applications such as LiDAR, optical satellite communication systems, and robotics. In order for an OPA to perform well, it should also be able to steer the beam of light in two dimensions to far distances and in quick succession. The focus in our work was to design and characterize two optical phased array designs that can perform beam steering reliably.

Multimodal sensor using embedded artificial intelligence for medical application

Alexandre Perrotton, Master's student, École de Technologie Supérieure

Poster and Oral Presentation

Machine Learning has made significant strides in medical data processing, addressing the challenge of interpreting intricate health signals. In this project, we have developed a system integrated into a KN95 mask to acquire various vital signals. It utilizes a matrix of 38 humidity sensors printed on a polyimide substrate. Data processing is embedded in an autonomous device, employing TinyML algorithms (edge computing) for data enhancement. This setup enables the collection of pulmonary parameters such as frequencies and air volumes, while also monitoring mask water saturation and detecting respiratory anomalies. In addition, our system is capable of detecting mask leaks.

Spray coated Bentonite and Multi-walled Carbon Nanotube biosensor for Uric Acid detection

Rebecca Park, Bachelor's student, University of Calgary

Poster and Oral Presentation

Detecting uric acid (UA) concentration is important for diagnosing and treatment of various diseases including renal, cardiovascular, and neurodegenerative diseases. The enzymatic biosensor for UA detection has been studied using bentonite (Bent) and multi-walled carbon nanotube (MWCNT). Using spray coating method, the bent-MWCNT nanocomposite solution was coated on screen-printed carbon electrode then the uricase enzyme (UOx) was immobilized. Electrochemical measurement was performed to compare peak values for the different composition of Bent-MWCNT solution. The stability was tested through flow injection system.

Fabrication and characterization of a fiber optic radiochromic dosimeter probe for real time measurement of photon and proton irradiation

Rohith Kaiyum, PhD student, York University

Poster and Oral Presentation

A novel fiber optic probe is under development, utilizing a radiochromic sensor composed of lithium-10,12-pentacosa diynoate (LiPCDA), to accurately measure ionizing radiation dose in real-time for cancer radiation therapies. Upon exposure to high-energy radiation, LiPCDA undergoes polymerization, leading to an increase in optical absorbance signal. To facilitate real-time irradiation measurements, a newly designed phantom has been 3D printed. This enables the irradiation of film while securely holding optical fibers in transmission mode, allowing for real-time measurements at a frequency of approximately 1Hz. Our results show that a sensor probe may be fabricated with LiPCDA for real-time measurements.

Using Optical Sensors for SSA Detection Analysis on the 3000 Starlink Series

Vithurshan Suthakar, Master’s student, York University

Poster and Oral Presentation

Space Situational Awareness (SSA) involves the observation of Resident Space Objects (RSOs) and the maintenance of the existing RSO catalogue by using optical sensors. Hence, the observability of RSOs is crucial. The observability of an RSO by an optical sensor is primarily determined by the position of the observer with respect to the RSO, its composition, and the constraints of the observer's sensor. Establishing a detectability analysis for RSOs with well-defined parameters, such as the 3000 Starlink series, would aid SSA. Hence, this analysis enables the exploration of the sensor selection, placement, viewing angles, and parameters for optimized SSA observations.

AM-EDGE

Student Presentation Abstracts

Impacting the Viscoelastic Behaviour of Lightweight Multilayer Reinforced Rubbers

Elli Gkouti, Post Doctoral Fellow, York University

Poster and Oral Presentation

The current study focuses on the impact of adding material layers to rubber samples on their mechanical properties and operational lifespan. We used neoprene samples reinforced with polyester or nylon layers and found that while these layers improve stiffness and strength, they also reduce mechanical durability. The choice of layer material significantly affects rubber strength and resistance to deformation, with nylon increasing strength but causing faster coupon breakage, indicating a shorter operational life. Polyester-filled neoprene, while less stiff than nylon-filled ones, shows significant resistance to fracture cause by elongation. We also explored the effect of deformation speed on fracture behavior, revealing mitigated differences between polyester and nylon-filled neoprene at lower speeds. This research provides insights into the complex relationship between material composition, mechanical properties, and operational lifespan in rubber composites, aiding informed material selection for practical applications.

Fabrication of bone marrow extracellular matrix scaffolds with 3D printed predefined internal microarchitecture promoting vascularization

Joab Ogato, PhD student, York University

Poster and Oral Presentation

Including functional vasculature in engineered constructs has been a technical challenge preventing fabrication of thick (>1mm) viable tissue. Using proprietary 3D printing raw materials, a sacrificial mould is printed into which a type I collagen slurry is cast. After the sacrificial mould is removed, Human umbilical vein endothelial cells(HUVECs) are seeded in the scaffold microchannels and thereafter, incubated for 72 hours. Scanning electron micrographs show differentiated HUVECs attached to the microchannel surface. Future work is focused on co-culturing bone-marrow cells in the interstitial space while perfusing the HUVEC-lined 3D printed microchannels with cell culture media for bone marrow tissue engineering.

Optimizing Magnetic Performance of Fe-50Ni Alloy for Electric Motor Cores through LPBF: A Study of As-Built and Heat-Treated Scenarios

Masoud Ahmadnia, PhD student, McMaster University

Poster and Oral Presentation

This study aims to identify the optimal combination of process variables for laser powder bed fusion (LPBF) of electric motor (EM) cores using Fe-50Ni alloy. A thorough analysis of mechanical and magnetic properties, with a focus on its dynamic magnetic performance within 50-500 Hz frequency range, is presented. Optimized process parameters yielded relative densities above 99%. In the as-built condition, a hardness twice that of conventionally processed alloy and high ductility (>30% at rupture) were achieved. The significant improvement observed in the semi-static magnetic properties after heat treatment is attributed to a notable reduction in geometrically necessary dislocations (GNDs) density. Heat treatment did not significantly reduce the total loss at elevated testing frequencies because the energy loss in the as-built microstructure is lower than what is expected due to the activation of more domain walls resulting in a homogeneous distribution of eddy currents. This research demonstrates the LPBF process's potential for manufacturing electric motor soft cores, providing acceptable surface integrity, roughness levels, and desired coercivity and permeability. However, the high total loss, specifically at elevated frequencies, encourage reconsideration of conducting heat treatment, specifically when the working frequency of the motor is beyond 400 Hz.

Label-free, microwave-based droplet microfluidic system for the detection of CTCs from whole blood

Nikhil V Giri, PhD student, University of Waterloo

Poster and Oral Presentation

Cancer affects more than 10 million people globally. However, around 90% of the deaths are due to cancer metastasis rather than the primary tumour itself. Cancer metastasis is the process of cancer proliferation by the circulation of tumour cells (CTCs) from the primary site to a different site through blood vessels forming one of the earliest stages of cancer. In this project, we employ a microwave split ring resonator (SRR) sensor to detect CTCs in whole blood samples. Further, we also utilise the sensor to differentiate between different CTCs

(MCF-7 and HCT-116) and to detect CTCs with no defined antibodies. Thus, we believe our system can help in early detection of cancer.

Applying LiMCA Sensors for the Detection and Measurement of Microbubbles in a Low Melting Point Temperature Alloy

Rohit Tiwari, PhD student, McGill University

Poster and Oral Presentation

LiMCA (Liquid Metal Cleanliness Analyzer) technology, derived from ESZ (Electric Sensing Zone) technique, has undergone considerable refinement and adaptation since its inception. Since 1980, there has been a noteworthy surge in its evolution, resulting in development of multiple variants tailored for various metal systems, such as aluminum, magnesium, copper, and steel. This progression has established LiMCA as the industry standard for real-time monitoring of non-metallic inclusions in liquid metals, particularly within the aluminum sector. This study introduces an in-situ, real-time method for measuring bubble sizes and their distribution in a low melting point alloy, Cerrolow, using the LiMCA system.

Effect of Reverse 4-Point Bending on Tissue-Engineered Cartilaginous Constructs

Saba Rafieian, PhD student, University of Toronto

Poster and Oral Presentation

This study aims to investigate the effect of reverse bending as a mechanical stimulation method on the quality of tissue-engineered cartilage, focusing on the simultaneous application of tension and compressive forces to mimic the multiaxial loads experienced by native articular cartilage. This study reveals a relationship between mechanical bending strain and its influence on the composition and properties of engineered cartilage constructs. By elucidating the strain-specific responses, it paves the way for optimizing mechanical conditioning protocols to enhance the functionality and structural integrity of engineered cartilage, offering promising avenues for advanced cartilage repair and reconstruction strategies.

Effect of pipeline steel microstructure on hydrogen uptake after gaseous and electrochemical charging

Tonye Alaso Jack, PhD student, University of Saskatchewan

Poster and Oral Presentation

Amid mounting global pressure to curb greenhouse gas emissions, hydrogen emerges as a critical player in future decarbonization strategies. However, for effective hydrogen transportation via steel pipelines, understanding the relationship between steel microstructure and hydrogen uptake is crucial to address hydrogen embrittlement concerns. But limited facilities for gaseous hydrogen testing pose challenges. Hence, a comparison between gaseous and readily available electrochemical testing methods is needed. Using microstructural analysis, thermal desorption, and hydrogen diffusion studies, results reveal the contributions of microstructural features, with electrochemical ingress showing higher sensitivity to microstructure, and dislocation density playing an important role in hydrogen ingress and retention.

Unveiling Lunar Resources: Electrochemical Demonstration of Aluminum Extraction from a Lunar Regolith Simulant

Xavier Walls, PhD student, Carleton University

Oral Presentation

There is currently a growing interest in developing technologies capable of utilizing in-situ resources on the Moon. In this project we are focusing on the potential to selectively extract Aluminum (Al) from the Moon. This element is abundant in the lunar regolith, and it could provide great utility for a possible extended human presence. So far, we have demonstrated our capability to extract Silica (SiO2) and Alumina (Al2O3) from a lunar highland simulant (LHS-1). The objective of this project is to demonstrate the next step in this process, which consists in electrochemically transforming the previously produced Al2O3 into metallic Al.

Understanding Wire Fabrication for Additive Manufacturing on the Moon. A Laboratory Demonstration of Wire Drawing Using Different Aluminum Alloys

Xavier Walls, PhD student, Carleton University

Poster Presentation

On the eve of humankind's return to the Moon, the possibility of maintaining a sustained human presence has been raised. To achieve this, it would be necessary to utilize lunar resources for manufacturing. Recently, additive manufacturing (AM) has been booming as a highly-versatile process. We have previously demonstrated the feasibility of extracting metallic aluminum from lunar regolith. We suggest it would be possible to generate a set of different lunar alloys on the Moon from which wire could be produced and used as feedstock for AM. In this study, we present the results of wire drawing different lunar-viable aluminum alloys.

Development of Electrospun Biocompatible Scaffolds for Vascular Tissue Engineering

Youssef Demashkieh, PhD student, York University

Poster and Oral Presentation

On the eve of humankind's return to the Moon, the possibility of maintaining a sustained human presence has been raised. To achieve this, it would be necessary to utilize lunar resources for manufacturing. Recently, additive manufacturing (AM) has been booming as a highly-versatile process. We have previously demonstrated the feasibility of extracting metallic aluminum from lunar regolith. We suggest it would be possible to generate a set of different lunar alloys on the Moon from which wire could be produced and used as feedstock for AM. In this study, we present the results of wire drawing different lunar-viable aluminum alloys.

DITA

Student Presentation Abstracts

Trajectory data mining

Ali Faraji, Master's student, York University

Poster and Oral presentation

Research on trajectory data mining relies on appropriate datasets, including GPS-based geolocations, check-in data to points of interest (Pois), and synthetic datasets. Even though some data are accessible, the majority of mobility datasets are typically discovered through ad-hoc searches and lack comprehensive documentation of their generation process or source to reproduce curated or customized versions of them. At the same time, there has been a growing interest in a new type of mobility data, describing trajectories as sequences of higher-order geometric elements like hexagons that offer several benefits: (i) reduced sparsity and analysis at different granularity levels, (ii) compatibility with popular machine learning architectures, (iii) improved generalization and reduced overfitting, and (iv) efficient visualization. To this end, we present Point2Hex, a method and tool for generating higher-order mobility flow datasets from raw trajectory data. We used Point2Hex to create higher-order versions of seven popular mobility datasets typically employed in trajectory-related technical problems and downstream tasks, such as trajectory prediction, classification, clustering, imputation, and anomaly detection, to name a few.

Trajectory Prediction Learning Using Deep Generative Models

Amirhossein Nadiri, Master's student, York University

Poster and Oral presentation

Trajectory prediction involves estimating the future path of an object using its current state and historical data, with applications in fields like autonomous vehicles and robotics. Recent approaches using deep learning analyze past trajectory data to predict future movements, but these models often struggle with complex spatial dependencies. To overcome these challenges, we introduce a novel model that uses generative models and higher-order mobility flow representations (hexagons). Our model gets as input historical trajectoriesand a trajectory's current state and predicts the next k trajectory steps. In addition, it incorporates a beam search variant to explore multiple paths while maintaining path continuity. Our modelsignificantly outperforms current leading methods and other baselines by up to 60% on various datasets. We also explore different prediction horizons and conduct studies to assess the impact of model components on performance.

Predicting Persisting Post Concussion Symptoms Using Kinematics Measured During an Augmented Reality Task

Anton Machula, Master’s student, York University

Poster and Oral presentation

Background

We interact indirectly with our environment daily, wherein the goal of an action and its required movement must be mapped together. Such tasks require cognitive-motor integration (CMI), in which rules dictate the relationship between perception and action. CMI neural control networks rely on intact frontal, parietal, and subcortical brain connectivity that may be compromised following sport-related concussion, resulting in impaired ability to engage in complex movements.

Objective

To investigate whether head and hand position while performing an Augmented Reality (AR) task can classify concussion history, thus providing predictive potential for persistent postconcussion symptoms (PPCS).

Methods

To probe CMI and vestibular function, 15 participants (4 concussed), engaged in an AR (Magic Leap, Inc.) whole-body task with 8 conditions of increasing complexity. First, participants walked naturally while moving virtual objects to colour-matched targets with direct hand to object interaction. Subsequent levels introduced vestibular and cognitive challenges, including tandem walk, indirect hand-to-object movement, and altered object-target colour matching. Kinematic measures included participant’s head and handheld controller position (pitch/roll/yaw, X-Y-Z, 60 Hz sampling rate). Data were preprocessed using a fast Fournier transform for feature extraction and noise reduction. To identify PPCS individuals, a deep learning (DL) model was developed using a time-series split k-fold-cross validation method with five segments.

Results

Our DL model distinguished concussed and non-concussed participants with a classification accuracy of 94%. In addition to current concussion classification, the model successfully identified a participant with concussion 13 years prior, and one with a history of sports-related, repeated sub-concussive impact.

Conclusions

Results indicate that a sophisticated DL of head movement and upper limb motion during whole body goal-oriented tasks can classify concussed and non-concussed individuals. The ability to identify concussion-related impairments in CMI performance offers a readily accessible method to assess neural functioning and brain network integrity known to be disrupted by concussion.

DMBench: Load Testing and Benchmarking Tool for Data Migration

Fares Hamouda, Master's student, York University

Oral presentation

Data migration refers to the set of tasks around transferring data over a network between two systems, either homogeneous or heterogeneous, and the potential reformatting of this data. Combined with large volumes of data, resource constraints and variety in data models and formats, data migration can be critical for enterprises, as it can consume a significant amount of time, incur high costs, and pose a significant risk if not executed correctly. The ability to accurately and effectively predict these challenges and plan for proper resource, time and budget allocation is vital for the proper execution of data migration. In this work, we introduce the concept of load testing and benchmarking for data migration to allow decision-makers for higher efficiency and effectiveness when planning for such tasks. Our framework aims for extensibility and customizability to enable the execution of a greater variety of tests. Here, we present a prototype architecture, a roadmap of how the development of such a platform should proceed and a simple case study of how it can be used in practice.

Data Siphoning Attacks on ICS and the Critical Role of Cryptoperiods

Gabriele Cianfarani, Master's student, York University

Poster and Oral presentation

Industrial Control Systems are built on the foundation of machine-to-machine communication, integrating hardware and software to ensure efficient and secure operations. With the use of cryptography, sensitive data can be securely transmitted and stored - accomplished by assigning unique keys to designated groups. Keys are rotated on a regular basis, called a cryptoperiod, to mitigate the risk of a key compromise and ensure that encryption remains effective over time. This presentation discusses PIRAT, a framework for determining the optimal cryptoperiod in an OPC UA group. PIRAT incorporates security requirements, communication data, and threat models to provide a cryptoperiod that satisfies an organisation's risk tolerance while minimizing disruptions.

Modelling the risk of infection at a point-of-interest

Nina Yanin, Master's student, York University

Poster and Oral presentation

Human mobility can greatly impact the transmission of infectious diseases. People traveling from one location to another can bring pathogens to new communities, particularly in highly populated and crowded areas. Quarantine and isolation measures can control the spread of illness by limiting the movement of infected individuals, but these tactics have socioeconomic drawbacks. Additionally, individuals may not comply with these measures, making them ineffective. A better approach is to educate people about the risks of their mobility, provide alternatives, and help them to make informed decisions. In this research, we introduce the problem of optimal risk-aware point-of-interest (POI) recommendations during epidemics, where people get recommendations on what POI to visit that reduces the risk of getting infected. The risk of infection at a POI is modeled based on its capacity and visit patterns over time. Then, we present a method that provides personalized recommendations, while at the same time optimizes a global utility function, where, if everyone follows the recommendation, the overall risk is minimized. In contrast to current approaches, our methods can take into account concurrent user requests, made within the same time period, that could potentially affect the relative risk at POIs. An extensive evaluation was conducted, using real-world data coming from three major cities in Canada, which showed that our method outperform the current state of practice method and other sensible baselines, on varying settings. Specifically, our method presented a decrease in the relative added risk of infection by 99.87%, 71.56% and 61.54% at each city, respectively. Our optimal risk-aware recommendation method has the potential to reduce infection risk by promoting responsible behaviors within communities.

Decision-support platform development to address key challenges in Site Reliability Engineering (SRE)

Wejdene Haouari, Master's student, York University

Poster and Oral presentation

Our project aims to develop a decision-support platform to address key challenges in Site Reliability Engineering (SRE) by adeptly mining event logs with machine learning to prioritize critical events. By applying ML algorithms, we expect to reduce Mean Time to Recovery (MTTR) and minimize revenue loss, efficiently balancing time and budget constraints. This initiative promises to enhance operational efficiency and provide SRE teams with effective tools for rapid and informed decision-making, mitigating the financial impacts of system downtimes.