ABSTRACT BOOK

CREATE ANNUAL SUMMIT 2023

MAY 1-2, 2023

Content

Guest Talks

Leading with Equity, Diversity, and Inclusion in Mind

Lisa Cole

Abstract

Let's explore leadership together through the lens of equity, diversity, and inclusion. In this session, we will discuss the role of leaders in creating the cultures and conditions for people to contribute and thrive in dynamic teams and the importance of reflective practice that supports personal growth and learning along each of our journeys. As thought leaders, innovators, and creators of change, our privilege, power, and potential for influence requires each of us to consider the role we play in creating an inclusive future for all.

Speaker Bio

Lisa Cole is a passionate, award-winning educator, and system leader in STEM (Science, Technology, Engineering and Mathematics) Education. She is the Director of Programming at k2i (kindergarten to industry) academy at the Lassonde School of Engineering, an innovative ecosystem of diverse partners, committed to dismantling systemic barriers to opportunity for underrepresented students in STEM. Lisa is an advocate for diversity and inclusion in STEM with experience providing workshops, consulting on the development of resources, managing large scale projects, developing multi-stakeholder partnerships, and facilitating diverse teams. She believes that STEM literacy is important for all. Through her work, she hopes to inspire leaders, educators, students, and communities to become future innovators, critical thinkers, and problem solvers.

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Practical Considerations of Imaging Technologies in Fluorescence Microscopy

Dan Stevens

Abstract

The number of fluorescence microscopy techniques commonly found in an academic imaging facility has exploded in the past two decades. The basic camera and laser scanning confocal have been joined by lightsheet, two-photon and a variety of superresolution technologies. Choosing the best technology in order to extract the desired data from an experimental model is not always a simple task. This talk will introduce a range of fluorescence imaging modalities and discuss the practical considerations of each, including sample preparation, sensitivity, speed and resolution.

Speaker Bio

Dr. Dan Stevens is an Application Specialist for optical microscopy with Carl Zeiss, the leading supplier of optical microscopes in academic research for over 150 years. Since joining Zeiss in 2006 while completing his doctorate, Dan has worked across Canada and the USA at leading academic institutions, teaching and demonstrating microscopy technologies. A graduate of the Department of Molecular and Medical Genetics at the University of Toronto, Dan came to microscopy as a method of evaluating the impact of transgenic manipulation on mouse models of human disease. As a routine user of widefield, confocal, two-photon, light-sheet and various superresolution techniques, Dan advises academic groups on the best imaging technology to meet their experimental requirements. On good days this means producing images of things that have never been seen before.

A Challenge Problem in Autonomous Robotics: Precision Control of Flexible Systems

Wen-Hong Zhu

Abstract

Autonomous robots are expected to execute tasks autonomously. An autonomous system is generally a feedback control system at task level, from environment awareness as “measurement” to decision making as “control action.” Such a system is often internally supported by a motion control system that directly makes use of commanding and tracking control at the lowest signal level. In this speech, a challenging problem, precision control of flexible systems, is presented as an essence in pursuing successful autonomous operations for space robotic manipulators. Concentrated on two technical elements, namely control bandwidth and system natural frequency, industrial trend, technical difficulties, drawback of current practice as well as possible directions for solution are outlined.

Speaker Bio

Wen-Hong Zhu received his PhD from Xi’an Jiaotong University in 1991 and published his PhD work in IEEE Trans. on Robotics and Automation in 1992. He was awarded more than four PDFs and worked at four institutions in China, South Korea, Belgium, and Canada, before joining CSA in 2001. He is a book author (Virtual Decomposition Control) and specialized in precision control of complex robotic systems.

Environmental Sustainability – The Road Travelled

Kevin Matthews

Abstract

Kevin is a pioneer in the business of Anaerobic Digestion (AD) of food waste. He developed the first commercial scale AD plant in North America. Today such plants are numerous. Kevin will speak about his journey. He will also speak about the environmental sector and provide some perspectives on the exercise of taking ideas and research through to commercialization.

Speaker Bio

Kevin is a management consultant with 30 years' experience in developing, building and operating bio-energy facilities. Kevin was the founder and President of CCI BioEnergy Inc. (CCI), a privately-owned company based in Toronto. The company is focused on building and operating both large scale municipal anaerobic digestion plants that utilize the BTA® Process as the core technology, and micro-scale anaerobic digestion plants utilizing technology developed by Qube Renewables out of the UK. In 2021 Kevin sold CCI and continues to provide consulting services to the new management. Kevin is also the founder and owner of Sustainable Resource Solutions Ltd. (SRS) through which he delivers his consulting practice. Kevin's expertise lies in:

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

Security and Societal Challenges as a Consequence of AI Advancements

Vio Onut

Abstract

With the exponential advances in AI, the potential reuse of these technologies to enhance cyber-attacks is a reality that security professionals face. We will look in particular at misuses of Deepfake technology that allows altering someone's appearance in a video. It is easy to see how this irresponsible use can augment a social engineering attack making it more credible. Let's take together a journey through a set of malicious uses of AI technology, from relatively low-impact consequences to state actors trying to overpower countries. We welcome participants to think about instances where they use AI technology and how a hacker could take advantage of that.

Speaker Bio

Iosif-Viorel (Vio) Onut is passionate about accelerating curriculum and product innovation through R&D. In the past decade, he has managed more than 150 research projects involving 35 universities, led by over 90 professors for over 360 students and over 330 IBM staff. He specializes in cybersecurity and cybercrime. He finished his Ph.D. in 2008 at the University of New Brunswick, specializing in network security, and has worked in security for the past 20 years. Vio holds multiple positions, he currently is Co-Director at the uOttawa-IBM Cyber Range; Adjunct Professors at the University of Ottawa; and Senior Manager, R&D Strategy at IBM Advanced Studies Canada.

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

Oral Presentation

The international Mars Ice Mapper mission is tentatively scheduled to launch in 2028 with a main goal of quantifying the presence, depth, distribution and purity of water ice at the sites that are promising for future human exploration and colonization of Mars. In preparation for this mission, we aim to quantify the performance of a dual mode L-band SAR/Sounder radar in the field. Flights will be made with the Simon Fraser radar system over locations with buried ground ice. My project will be to support interpretation of the data by making ground-based measurements with ground penetrating radar and extracting cores. Most important for assessing the radar performance is finding the dielectric properties of the cores. To do this, I will use a Vector Network Analyzer at York University within the same frequency range as the airborne radar to determine these dielectric properties.

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

Ahmad Al Ali, PhD student, York University

Oral Presentation

Space technologies have risen significantly this century. However, the density of drifting objects in orbit is reaching dangerous levels; where debris will start posing a great threat of collisions in space and compromise any future space missions.

Space robotics are considered one of the most promising applications for orbital debris removal. This research explores novel approaches namely artificial intelligence (AI), to control a free-floating space robot for target capture.

Employing Reinforcement Learning, the robot learns to navigate an optimal path towards reaching its target safely, without collision, and singularity free. Furthermore, we will test these algorithms experimentally in our lab.

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

Angela Huang, Master student, York University

Oral Presentation

The use of additive manufacturing techniques in spaceflight presents an opportunity to conserve resources by allowing for on-demand printing of parts. However, unlike on Earth where gravity assists in interfacial bonding between layers of 3D-printed polymers, microgravity environments lack this effect, resulting in negative impacts on mechanical properties such as the tensile, compressive, and flexural strength of printed parts.

To address this challenge, research investigates the effects of microgravity on the material and mechanical properties of ABS samples produced using fused filament fabrication. A novel methodology for 3D-printing on Earth is introduced, where different printing parameters are used to generate samples with varying degrees of gravitational pull.

Samples are evaluated for tensile, compressive, and flexural properties, fracture morphology examined using SEM, and bulk characteristics using microtomography. Data analysis will employ a machine learning integrated process-structure-property framework. The research aims to advance additive manufacturing methods in spaceflight by developing a framework of printing parameters to produce high-quality parts in microgravity environments.

Co-ordinated Multi-Rover Control

Antonia Hoffman, Master student, Toronto Metropoletan University

Oral Presentation

Two rovers will carry a common payload (eg. a Robot Electronics Unit) on a coordinated trajectory between bases of exploration on another planet. Each rover features 4 steered wheels and 2 n-DOF manipulator arms. Our team will develop the control algorithm to drive this system. It must respond in real-time to challenging terrain and unknown changes in environment. Our current focus is on Model Predictive Control, which calculates control input by minimizing a quadratic cost function over a time interval called the prediction horizon. We will develop a VR testing environment using MATLAB and Unity prior to implementation in hardware.

Deep Reinforcement Learning for Grasping Free-Floating Target with Tactile Sensor

Bahador Beigomi, PhD student, York University

Oral Presentation

This study presents a unique approach to robotic grasping in micro gravity using Deep Reinforcement Learning (DRL), addressing challenges like controlling contact force. Our method employs the Soft Actor Critic (SAC) algorithm for automated feature design, enabling robots to learn grasping strategies through trial and error. We develop a shaped reward function incorporating three-fingered hand poses for efficient learning. Trained in the Pybullet simulation environment, our approach is demonstrated with a three-finger Robotiq gripper. The contributions include applying the SAC algorithm, creating a shaped reward function, and adapting to micro gravity grasping challenges, enhancing performance across various applications.

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

Bingze Xia, PhD student, Concordia University

Oral Presentation

This presentation delves into the cutting-edge technology of Unmanned Aerial Vehicle (UAV) autonomous navigation and de-confliction, powered by deep reinforcement learning. We will explore the integration of sensor setup, including Lidar and 3D cameras, that enhances the UAV's situational awareness and decision-making capabilities. The Twin Delayed Deep Deterministic (TD3) policy gradient method will be discussed, as it enables robust and efficient learning for UAV control. We will also examine the application of the Markov Decision Process for modeling and solving the UAV navigation problem. The presentation will showcase the UAV's ability to autonomously navigate complex environments, while adeptly avoiding both static and moving obstacles, paving the way for future advancements in the field of autonomous aerial systems.

Capturing an Unknown Uncooperative Target with 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 capturing an unknown uncooperative target rigid body using multiple spacecraft. The contributions are the design of novel swarm intelligent algorithms for capturing tumbling targets in space as well as the enhancement of current mapping techniques to cope with the challenges of a changing environment like a free-floating body.

Dynamics of On-orbit Additive Manufacturing Platform

Fuzhen Yao, PhD student, York University

Oral Presentation

Since the launch of the first artificial satellite in 1957, space missions have grown in complexity, with increasing payload sizes requiring multiple transports and on-orbit assembly. On-orbit manufacturing (OOM) offers significant advantages over traditional cargo launches, including cost savings and reduced risks to astronauts. 3D printing is crucial for OOM, and extravehicular OOM is preferred for manufacturing large structures. The OSAM-2 mission has successfully conducted ground-based printing tests, but the dynamical characteristics of large-scale structures during on-orbit printing have not been investigated. In this paper, we employ a platform similar to OSAM-2 to investigate the coupled rigid-flexible dynamical characteristics during on-orbit printing using finite element method.

Image Restoration Using Diffusion Models

Hamidreza Dastmalchi, PhD student, York University

Oral Presentation

Image restoration aims to recover degraded images affected by various factors, including blur, noise, and compression artifacts. Image restoration is an ill-posed inverse problem, since there are multiple solutions for each degraded image. Deep learning limits the solution space by modeling the posterior distribution and sampling from it to solve the inverse problem. Although most techniques are supervised and tailored to specific problems, an unsupervised deep learning approach can tackle general inverse problems. In this work, we propose an unsupervised restoration algorithm based on diffusion models to solve multiple problems, including denoising, super-resolution, deblurring, inpainting, and colorization.

Grid Cell Detection of Dandelion Weed Centers via Convolutional Neural Network

Ibrahim Babiker, PhD student, Concordia University

Poster Presentation

We present a novel method for detecting dandelion weed (Taraxacum officinale) plant centers in perennial ryegrass from images. A primitive region proposal method generates proposals. Those containing weed leaves are taken and plant centers are labeled. The samples are divided into a grid of cells and the labeled point is considered the truth cell. A radial map is generated from the spatial location of cells w.r.t. the truth cell. A fully convolutional network is trained to detect the positive truth cell using novel loss functions based on these maps, which are compared. Favorable results are yielded and future work, discussed.

Lunar Regolith Thermal Model for Rover Instrument Qualification at the Moon's South Pole

Jin Sia, Master student, Western University

Oral Presentation

The lunar rover dual sensor multispectral imager (MSI) being developed by our team at Western University is designed for exploration at the Moon's south pole, where it must survive temperatures below 100 K during the two-week lunar night. To support thermal simulation and design, a regolith thermal model was developed that accurately predicts nighttime temperatures. The engineering-focused model of Christie et al. (2008) was augmented with newer material models developed from data returned by the Lunar Reconnaissance Orbiter. Comparison of models and validation against empirical measurements indicates that the nighttime thermal environment is more severe than originally expected.

Autonomous real-time Path planning of dual-arm space robots for on-orbit servicing of spacecrafts via deep reinforcement learning method

Maryam Ashkbous Esfahani, PhD student, Polytechnique Montréal

Poster Presentation

On-orbit servicing of malfunctioning spacecrafts sometimes requires too delicate jobs such as switching out gyroscopes, repairing thermal shielding, and replacing defective cameras. These tasks are mainly done by astronauts through manned space missions which are both pricey and risky for astronauts. Dual-arm manipulators offer an alternative to handle the job as an autonomous task. This project aims at path-planning of dual-arm robots to provide accurate collaboration of two arms via deep reinforcement learning method, which generates continuous actions with tractable computation as a practical tool for real-time autonomous tasks.

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

Nishanth Rajkumar, Master student, Concordia University

Poster 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.

Robust Finite Element Kalman State Estimation Algorithm for Flexible Space Tether Systems

Qi Zhang, PhD student, York University

Oral Presentation

This paper proposes a robust finite element Kalman filter for the state estimation of flexible space tether systems, which is difficult to measure directly by deploying sensors along the flexible tether. A fully expandable and scalable approach is developed by decomposing the measurement model into three parts: position and velocity information at tether ends by connected spacecraft, distributed fiber optic strain measurement along the tether, and a model-based virtual sensor. A novel inverse nodal position finite element method is developed to convert the distributed fiber optic strain measurement along the tether into the position estimates of internal nodes in the finite element model of the tether in the spatial domain. The model-based virtual sensor model is established to estimate the velocities of internal nodes by combining the position and velocity measurements at the tether ends and the internal nodal positions. Then, a robust finite element Kalman state estimator is developed for the flexible space tether system by integrating the real position/velocity sensors, fiber optic strain sensor, and virtual sensor into a hybrid measurement model. The observability, stability, and robustness of the proposed estimator are mathematically proven. The effectiveness of the estimator is demonstrated through numerical simulations of a space tether system in orbit, and the method can be extended to any flexible body system.

In-Situ Skin Bioprinting Techniques

Muhammad Salman Chaudhry, PhD student, York University

Poster Presentation

The advent of 3D bioprinting in tissue engineering has become an example of additive manufacturing's impact in many other fields. Technology advances in 3D printing, coupled with increasing sophistication required for printing on biological platforms, have the potential to revolutionize tissue engineering. In this study, we present a novel approach to in situ bioprinting to address the challenges inherent in operating at the interface between complex living systems and technology. These attributes principally derived from the variation of customary 3D printing strategy to the innately unpredictable frameworks of the human body. The aim of this exploration is to overcome this issue by tending to certain innovative hindrances that obstruct consistent in situ 3D printing of biological tissue. Clearly, 3D printing has enabled the future of tissue bioengineering through its state-of-the-art technology. A further development of 3D printing technology will be necessary to successfully adopt the technique for in situ printing.

IGPN : Identity-embedded GAN Prior Network for Face Super Resolution

Seyed Nima Tayarani Bathaie, Master student, York University

Oral Presentation

GANs are widely used in image Super Resolution, exploiting adversarial and pixel-wise loss functions to balance the correctness and realness of the generated images. GAN-prior methods improve restoration quality but may not preserve identity in reconstructed images. To address this in facial images, we propose the Identity integrated GAN Prior Network (IGPN), combining an Adversarial AutoEncoder (AAE) with a pre-trained StyleGAN network. The AAE suppresses noise and enriches image representations with identity information used to generate styles, while Multi-scale features and parsing maps aid maintaining the global face structure. Experiments demonstrate that IGPN surpasses state-of-the-art methods in upscaled image quality.

Decoupling Interaction Matrix in Image-based Visual Servoing: A Novel Approach for Canadarm2 Automation

Shayan Ghiasvand, Master student, Concordia University

Poster Presentation

This research aims to automate the catching process on the International Space Station using Canadarm2. We fabricated a targeting pin identical to the one on the ISS and tested our method with the Denso robot. After successfully implementing and analyzing six visual features, coupling issues in the interaction matrix were observed, particularly in rotations about the camera's x and y axes. To address this, we aim to propose two novel features for a more decoupled interaction matrix. The proposed feature is a fraction of two generalized polynomials based on image moments and several coefficients. It is possible to optimize the coefficients in order to achieve a decoupled matrix and improve system performance.

Design of Space-Hardened Electronics in a Multispectral Imager for Lunar Rover Applications

Stephen Amey, Master student, Western University

Oral Presentation

Spacecraft instrumentation is important in a variety of applications ranging from Earth observation to planetary surface investigation. Outside the Earth's atmosphere, spacecraft instrumentation is subject to harsh conditions arising from high energy radiation and vast temperature swings. If not properly designed to withstand these conditions, electronic components have the potential to fail resulting in the loss of the instrument or mission. Recently, a Multi-Spectral Imager (MSI) prototype capable of capturing images over a wide spectral range (400-1700nm) was built as part of a CSA funded project at Western. The next step is to design and fabricate a space-rated instrument suitable for the lunar environment. This work aims to understand the conditions that will be experienced by the instrument's electronic sub-system on the lunar surface, investigate how electronic systems should be designed for these conditions, and then apply these findings to the design and component selection of the MSI's electronics sub-system.

A Computational Control Framework by Discretized Control Lyapunov Functions and Consensus Control for Flexible Body Dynamic Systems

Zhengze Liu, PhD student, York University

Oral Presentation

The Finite Element Method (FEM) has widened the use of numerical methods to investigate elastic system dynamics. However, there is a lack of discretized computational control method for such systems. This research aims to develop a systematic approach for designing a consensus stabilizing control of flexible body dynamic systems by extending Sontag's formula using FEM. A Sontag's type controller will be designed individually in each element to simplify the controller design. By leveraging the interconnectedness of FEM, global system stability is ensured, and the stability of the entire system can be guaranteed through individual consensus controls in a single element.

TABES

Student Presentation Abstracts

TABES

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

A combinatorial approach towards the treatment of landfill leachate

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

Oral Presentation

The study focuses on the combination of biological and electrochemical methods- extracellular polymeric substances (EPS) and electrocoagulation (EC) for the treatment of landfill leachate (LFL). LFL is formed on rainwater passing through the waste placed in landfills. It consists of several dissolved organic materials, for instance aquatic humic substances, volatile fatty acids (VFAs), heavy metals, inorganic macro components, highly toxic to the environment. Additionally, it displays the production of EPS using industrial waste by-products to further contribute to circular economy.

Determination of biomass chemical properties of three wood species by conventional standard approaches and near-infrared spectroscopy

Bouaziz Bilel, Master student, Université du Québec en Abitibi-Témiscamingue

Poster Presentation

This project aims to determine the chemical properties of biomass from three different wood species, namely Lodgepole Pine, White Spruce, and Willow, using conventional chemical analysis and Near-Infrared Spectroscopy (NIRS). We characterized the biomass samples by performing conventional chemical analysis and developed a prediction model using Partial Least Squares (PLS) and NIRS to predict the chemical properties of biomass non-destructively. The results showed that NIRS can be a reliable method for predicting the chemical properties of biomass, making it a valuable tool for future research and development in the field of renewable energy.

Enzymatic biodegradation of BTEX

Diego Alejandro Hernandez, Master student, York University

Oral Presentation

Nowadays, the economy's growth has led to more petroleum hydrocarbon production, including BTEX, which can leak from storage tanks and pipelines, posing a high risk of polluting groundwater through the hydrologic cycle. Groundwater provides freshwater to around 9 million Canadians, making BTEX contamination a public health concern. Enzyme-based biological approaches offer a safe, cost-effective, and environmentally friendly alternative to conventional methods. In this work, we study the production of BTEX-degrading enzymes such as catechol dioxygenases utilizing inducers such ethylbenzene and xylene isomers. A further analysis of the temperature, pH and inducer concentration levels will be conducted to optimize the enzyme production.

Elaboration, modeling of the durability of a wood -composite

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

Poster Presentation

The use of bio-composite materials is increasing dramatically for environmental and economic reasons. However, the acceptability and commercial applicability remains limited in the applications due to the lack of mastery of the durability. This study aims to develop a bio-composite material based on poly lactic acid (PLA) and reinforced with high content wood fibers. Various physicochemical characterizations such as ATG, DSC and FTIR, as well as thermomechanical tests such as thermomechanical analysis (TMA), mechanical dynamics analysis (DMA) and rheological characterization were carried out to predict the effect of wood content on the creep behavior. In addition, long-term prediction models were developed based on the data collected during the characterization and phenomenological models. These models will help manufacturers to predict and extend their service life of bio-composite materials.

Development of biodegradable fertilizer pots from wood industry residues: an ecological solution for sustainable agriculture

Fatma Bali, Master student, Université du Québec en Abitibi-Témiscamingue

Poster Presentation

This study aims to develop sustainable alternatives to plastic pots in agriculture using by-products from the wood industry. Different formulations of organic residues, such as thermomechanical pulp, mixed sludge, biochar, and chicken manure, are used as fillers for biocomposites based on polylactic acid. The development of biocomposites with a 50% reinforcement rate through mixing and thermo-pressing molding is carried out. Various characterization techniques will be used to assess the physical, chemical, and mechanical properties of the biocomposites. Additionally, the biodegradability and fertilizing properties of the biocomposites will be evaluated. This research contributes to the development of sustainable materials for use in agriculture.

The Emerging Biodiversity Market: The Conservation Impact Bond in Southwestern Ontario

Julia Bava, Master student, York University

Poster Presentation

Sustainable, nature-based solutions for waste valorization require financial supports that reach beyond government grants. The Conservation Impact Bond (CIB) is an emerging financial tool aimed at incentivizing conservation work. This project aims to 1) Assess waste management issues and ecological blind spots in rural Southwestern Ontario, 2) Understand the public's perception of the Conservation Impact Bond, and 3) Determine if the data from the In The Zone program supports the hypothesis that planting native plant species increases the biodiversity dividend. Commercialization of nature-based solutions offers existing biodiversity as a promising solution for ecological restoration.

Durability of biocomposites in high performance: hydromechanical behavior and modeling

Khouloud Bouaziz, Master student, Université du Québec en Abitibi-Témiscamingue

Poster Presentation

Moisture is one of the main causes of short-term aging and has a major influence on the service life of biocomposites. The objective of this study is to evaluate the hydromechanical behavior and the hydric aging of these materials. The study reveals a comparison of the effect of various wood fiber types in the polylactic acid and the polypropylene composites produced. Many formulations were used to study the physical-mechanical properties after immersion in water for different periods of time. Models are implemented for moisture intrusion and the effect on mechanical properties were developed and used to explain the experimental results.

A proof of concept for Azithromycin detection in water using molecularly imprinted polymer in a microfluidic device

Noha Hasaneen, Master student, York University

Oral Presentation

Antibiotics have been identified as emerging contaminants. A thin layer of molecularly imprinted polymer (MIP) made of acrylic acid as monomer, ethylene glycol dimethacrylate as cross-linker, azithromycin as template, and photo initiator was created inside microfluidic channels as synthetic receptors for Azithromycin antibiotic. To detect Azithromycin, fluorescein isothiocyanate dye (FITC) was used as an indicator for optical detection. The fluorescence intensity of the FITC greatly increased when exposed to 1000 ppm of Azithromycin after capturing and exposure to the dye. Future research is aimed at detecting lower concentrations, as low as 10 ppb in environmental water samples using this device.

Membrane bioreactor technology for the treatment of landfill leachate

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

Poster Presentation

A lab-scale MBR treating landfill leachate is investigated to ascertain the interaction between the hydraulic retention time (HRT) and the contaminants loading rate in removing frequently detected contaminants, such as total and suspended solids, chemical and biological oxygen demand, ammonia nitrogen, and total metals. Leachate was collected from a municipal sanitary landfill site located in Quebec, Canada with a maximum annual landfill capacity of 75,000 metric tons. Leachate was characterized for conventional pollutants. In addition, spectroscopic techniques, i.e., ultraviolet-visible (UV-vis) spectroscopy, Fourier-transform infrared spectroscopy (FT-IR) and 3D-Excitation Emission (3D-EEM) were used to characterize dissolved organic substances

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

Poster Presentation

In this work, epoxidized canola oil (ECO) is used as a novel compatibilizer for PLA and PBAT. ECO is produced and characterized using attenuated total reflectance Fourier transform infrared spectroscopy (ATR-FTIR) and proton nuclear magnetic resonance (1H NMR). Polymer blends are prepared using a batch mixer and characterized using ATR-FTIR, 1H NMR, scanning electron microscopy, differential scanning calorimetry and mechanical analysis. Polymer blends containing ECO demonstrate a significant reduction in PBAT phase size and thermal transitions (glass transition, cold crystallization and melt temperatures) and a significant increase in elongation at break while maintaining the same tensile strength and Young’s Modulus.

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

Reema, Master student, York University

Poster Presentation

Acidogenic fermentation of food waste using mixed microbial cultures can produce high-valued bioproducts such as volatile fatty acids (VFA) via complex microbial networks and metabolism. The long chain VFAs have higher economic value and easier recoverability as compared to short chain VFAs. However, the first step of hydrolysis is often the rate limiting step in this process where the breakdown of complex organic matter occurs. With pre-treatment of substrate, the hydrolysis step can be enhanced, thereby reducing the retention time for further acidogenesis to start. Thermal-alkaline pre-treatment is performed in batch reaction to assess the concentration and composition of long chain VFAs produced.

Study of the variation in physical and chemical properties of Scots pine wood

Sofien Elleuch, Master student, Université du Québec en Abitibi-Témiscamingue

Poster Presentation

This study investigates physical and chemical properties of Scots pine wood through non-destructive sampling of 19 families of this species planted in the Abitibi-Temiscamingue region in 2007. Wood density and ring width in both initial and final wood will be studied using non-destructive sampling, while the chemical properties such as cellulose, hemicellulose, lignin, and extractives will be determined on 14 trees in the form of discs using conventional methods and near-infrared spectroscopy (NIRS). Genetic parameters of these traits will be estimated through quantitative genetic analysis. The study aims to provide information on the quality of Scots pine wood and suggest genetic improvement strategies for its better utilization.

Advancements and Challenges in Photocatalysis for Sustainable Wastewater Treatment: Focus on Pesticides and Pharmaceuticals

Yeuhyun (Kevin) Kim, PhD student, York University

Poster Presentation

Photocatalysis has emerged as a promising green technology for wastewater treatment due to its ability to degrade organic pollutants and disinfect water. However, its application in real-world wastewater treatment is still limited by several challenges including low photocatalytic efficiency, instability, limited selectivity, and difficulties in deploying in a reactor. This comprehensive review will discuss current trends, limitations, and advancements in photocatalysis and its application in wastewater treatment. The principles of photocatalysis, including the band structures, charge transfer kinetics, and the role of surface structures and defects will be discussed along with various strategies for enhancing photocatalytic performance, such as the use of co-catalysts, doping, and heterostructures. Emphasis will be placed on the remediation of pesticides and pharmaceutical contaminants and their degradation mechanism. In addition, recent advances in photocatalytic reactor design will be highlighted, with the discussion of challenges and opportunities for scaling up photocatalysis for industrial wastewater treatment.

Hygrothermal effects on adhesively bonded CFRP-to-concrete systems

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

Oral & Poster 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 and externally bonded reinforcement 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.

MTA

Student Presentation Abstracts

Microsystems Technologies & Application

Design of an On-Chip Optical Phase Array Systems for Satellite Communications

Akash Chauhan

Poster Presentation

The Optical phased Array (OPA) has become a fascinating tool for beam steering for satellite applications, due to its lower size, weight, power, and cost when compared to mechanical beam steering mirrors since OPAs are made on an integrate micro-photonic platform. In this research we design and analyze a one hundred emitter dual ring OPA array on a Silicon Nitride waveguide platform. Preliminary characterization has been done in terms of efficiency, steering range, and resolution, and full system level calibration and testing is being explored.

Array design using rotational symmetry for optical phased array

Ilyas Kandid

Oral Presentation

Opitcal phased arrays are proposed to be a key component in solid-state beam steering systems. This can replace current light detection and ranging (LiDAR) systems that rely on moving parts, which will drive down costs and size. In order to perform well, the OPA should possess a large steering range and a narrow beamwidth. However, achieving both simutatenously has proved to be difficult. The steering range is severely impacted by aliasing artificats, known as grating lobes, which is a consequence from the uniform element spacing. We propose an array design that rotates adjacent sub-arrays to suppress the grating lobes.

Intelligent Detection of Contaminated Soil through Sensor Fusion

Mohammad Kazem Vakilzadeh Ebrahimi

Oral Presentation

Petroleum-based hydrocarbon (PHC) contaminations in soil are a pressing environmental issue. Conventional methods to assess soil contaminants are both time-consuming and expensive. In this study, we propose a novel system that employs sensors and artificial intelligence (AI) for rapid and precise hydrocarbon soil contaminant testing, while also taking into account the soil texture, a crucial parameter affecting the transportation of contaminants in soil. The system comprises a portable sample preparation kit, sensors, and an AI model primarily utilizing the near-infrared (NIR) sensor. This project represents a significant stride forward in the fight against soil contamination.

Fabrication and characterization of a fiber optic radiochromic dosimeter probe

Rohith Kaiyum

Oral Presentation

A fiber optic probe utilizing a radiochromic sensor made of lithium-10,12-pentacosa diynoate (LiPCDA) is being developed to measure ionizing radiation dose in real time for safe cancer radiation treatments. LiPCDA undergoes polymerization upon high-energy radiation exposure, increasing the optical absorbance signal. The dose sensitivity of the probe depends on the LiPCDA crystalline structure and optical path length. To account for variations in optical path length, an IR dye is incorporated into the LiPCDA formulation for active material calibration of the sensor. Our results show that the sensor material may be fabricated with sensitivity and calibration necessary for clinical dosimetry.

Measurement of Thermal Properties of Liquid Analytes Using Microfluidic Resonators Via Photothermal Modulation

Rosmi Abraham

Oral Presentation

Microfluidic channel-integrated cantilevers are considered as an established benchtop sensor platform for physical and thermal characterization of materials at the picogram amount of analytes. Here we conducted the analysis of thermal characteristics of liquid analytes using photothermal heating effect of the microfluidic cantilever. While the liquid analytes in the cantilever is locally heated by laser-induced irradiation, real-time tracking of resonance frequency shift of the microfluidic resonator allows the estimation of thermal properties of liquid samples. The heating results in the expansion of the liquid inside the channel which induces thermal stress on the walls of the channel and contributes a rise in the resonance frequency of the microfluidic resonator. The frequency shift is linearly dependent of the volumetric coefficient expansion of the liquid. A threefold improved sensitivity is observed when the second order flexural vibration mode is analyzed compared to that of the fundamental resonance. This approach, which combines photothermal heating and the dynamic mode of operation, can serve as a platform for the development of a portable, lab on a chip device for the use of real time detection of thermomechanical properties of fluids at low cost.

Detecting Pathogen Contamination in Water using Microfluidics and Imprinted Polymers

Shiva Akhtarian

Oral & Poster Presentation

There has been an increasing demand for inexpensive, rapid, and portable monitoring of pathogenic and indicator microorganisms in the medical and environmental sectors. The conventional methods of sensing these microorganisms include immunological assays, molecular tests, and cell culturing methods which are labour-intensive, time-consuming, and expensive while requiring trained personnel and complex equipment.

Point-of-Care (POC) devices have emerged as a promising path enabling inexpensive, rapid, and on-site sensing of biological contaminants with high selectivity, sensitivity and reproducibility. POC sensors rely on bio-recognition material e.g., antibodies, aptamers, bacteriophages, etc. that can specifically bind to the target microorganism. Molecularly imprinted polymers (MIPs), also called "synthetic antibodies," are polymeric recognition materials and are shown to have more robust recognition sites yet exhibit competitive affinity for target analytes compared to their biological counterparts.In our project, we optimize MIP compositions consisting of functional monomers compatible with virus and bacteria templates on microwires (MWs) as detection transduction interfaces. Utilizing microfluidics enables the fabrication of field-deployable and low-cost sensors, which would need a small sample volume and a short time for the measurements. Furthermore, microfluidic devices' high surface-to-volume ratio can lead to highly sensitive sensors. We characterize the MIP's selective binding properties toward target bacteria to gain an in-depth understanding of the physics of MIPs in bacteria-sensing applications. Due to the superior sensitivity of electrical transduction, we apply electrical characterization by coating bacteria-MIPs on the surface of microelectrodes to transform the bacteria binding event into an electrical readout signal.

AM-EDGE

Student Presentation Abstracts

C2C12 cell culture in pNIPAM 4D printed thermos-responsive hydrogels

Daphene Marques Solis

Oral & Poster Presentation

The potential offered by 4D printing can revolutionize various fields, including tissue engineering, since adding time as a dimension brings printed structures close to natural tissue behaviour. In special, 4D-printed hydrogels can change their proprieties when subjected to external stimuli – such as temperature – loosely mimicking natural tissue. The authors investigate the suitability of pNIPAM-based thermos-responsive hydrogels printed using digital light processing (DLP) as substrates for C2C12 mouse myoblast cell culture. The results suggest that pNIPAM hydrogels fabricated by 4D-DLP printing can be used as thermos-responsive cell substrates as long as the stiffness is sufficiently high.

On the fabrication and 3D printing of blood vessels

Joab Ogato

Oral Presentation

Three-dimensional printing has been employed in tissue engineering, producing functional tissues with biomimetic structures, and required mechanical properties. To obtain viable engineered tissue, vasculature is needed to provide nutrients and oxygen and remove waste products from the tissue. Including functional vasculature in engineered constructs has been a technical challenge preventing fabrication of thick (>1mm) viable tissue. Using a repurposed bioprinter, with proprietary material, a 3.5mm scaffold with internal microarchitecture for the growth of blood vessels to support development of viable tissues is presented.

A study on the Process-Structure-Property relationships in Laser Powder Bed Fusion of soft magnetic Fe-50Ni alloy

M. Ahmadnia, McMaster University

Oral Presentation

Fe-50Ni alloy has extensive use as the core of electric motors because of its high magnetic permeability. This article studies the effect of the three most significant parameters of LPBF on relative density (RD), surface roughness, microhardness, and D.C. magnetic performance and, for the first time, investigates the dynamic performance of as-built(AB) and heat-treated(HT) samples under alternating magnetic fields up to 500 Hz. RD higher than 99% with a microstructure almost 20% harder than traditionally processed alloy is obtained in AB condition. The maximum permeability and coercivity in AB samples are up to 915 and down to 262 A/m, respectively, showing a huge difference from the traditionally processed alloy. However, the D.C. magnetic properties improved significantly after heat treatment at 1200o C. Coercivity scaled down to 44 A/m, and the maximum permeability jumped to 10100 for the sample with Ev= 80 J/mm3 and are the best-published results for this alloy processed by SLM or DED so far, even comparable to the specifications of traditionally manufactured alloy. However, implemented HT process caused a 15-20% reduction in the hardness of the material and did not decrease the total loss at high working frequencies significantly. This research demonstrates the capability of the LPBF process to be utilized for manufacturing soft cores of electric motors. However, the total loss of the toroids at elevated frequencies is very high due to the large cross-section of the toroids, which necessitates a decrease in electrical conductivity.

An experimental investigation into thread formation during drop generation by pseudoplastic viscoelastic fluid at t-junction generators

Nikhil V Giri

Oral Presentation

Microfluidic devices have long been used to generate and manipulate emulsions and have widespread applications in pharmaceuticals for drug delivery, ink jet printing, food processing, chemical reactions, tumor destruction and so on. The manipulation of droplets in microfluidic channels and its applications have been demonstrated before by numerous authors albeit using Newtonian fluids like oil and water. Most materials of commercial interest are Non-Newtonian in nature and are relatively less explored compared to their counterparts. This project aims to investigate the effect of junction parameters, fluid viscosities on the thread generation by a Pseudoplastic Viscoelastic Artificial Tear Film and determine its variation with DTJ (Droplet at T junction) and DC (Droplet at channel) regimes.

Microbubbles Generation in Liquid Metals using Rotational Shearing and Induced Turbulence, and their Detection using LiMCA system

Rohit Tiwari, McGill University

Oral Presentation

Previous research has indicated that bubbles of approximately 500 μm are necessary to eliminate particles/inclusions smaller than ~50 μm in tundish-type scenarios. The present study showcases an experimental setup that uses high-speed rotational shearing combined with a low argon gas flow rate within a liquid metal, to purposively generate microbubbles within the required 500-600 μm size range. A new version of the Liquid Metal Cleanliness Analyzer (LiMCA) was concurrently developed in conjunction with this microbubble generator, to measure bubble size distributions, and confirm that this is feasible. This new setup will provide us with the quantitative evidence that all sub-50 micron inclusions can now be removed from liquid metals using argon microbubbles, by monitoring their dynamic removal from the melt with a standard LiMCA system, down to ~5micron diameters, during gas bubbling. This, in turn, will lead to greatly enhanced liquid metal quality, and markedly improved physical properties.

How 3D Printing is Helping Restore Hope for Ukraine's War Victims with Facial Injuries?

Saba Rafieian, Sunnybrook Research Institute; University of Toronto

Poster Presentation

The war in Ukraine has resulted in many individuals with critical facial and skull injuries. Surgery is needed to restore both form and function in these individuals and requires complex 3D reconstruction. Working with the Sunnybrook Ukraine Surgery Education Initiative and Calavera Surgical Design, we created surgical tool kits consisting of premade facial implants. Using FDM (Fused Deposition Modeling) technology, we 3D printed, sanded, polished, coated, sterilized, and packaged sets of facial implants made of ABS plastic. These implants form templates to contour the titanium mesh that is used to replace the defective bone and recreate the facial skeleton.

Importance of Nb in pipeline steels for acidic service: A microstructural perspective

Tonye Alaso Jack, University of Saskatchewan

Oral Presentation

Niobium (Nb) is known to improve the strength and toughness of pipeline steels, but little is known about its microstructural effects on corrosion or hydrogen-related degradation. This study uses similarly processed Nb-containing and deficient pipeline steels to investigate the effects of the resulting steel microstructure under simulated acidic operation conditions. Using several material characterization techniques as well as experimental and mechanical tests, the results confirm a lower failure resistance and a higher tendency for hydrogen embrittlement for the Nb-deficient steel, especially in the presence of mechanical loading. Remarkably, this performance was linked to their microstructural characteristics and hydrogen retention capabilities.

Lunar regolith beneficiation and chemical processing for the extraction of additive manufacturing grade aluminum

Xavier Walls

Oral Presentation

There is currently a growing interest, from both the public and private sectors, in developing technologies capable of utilizing in-situ resources in space. One of the main objectives is the Moon, since the development of such technologies would allow the establishment of a sustainable human presence there. In this project we seek to separate the different components of a lunar regolith simulant, further electrochemically reducing the metallic oxides and finally utilizing the obtained aluminum in additive manufacturing. We have been able to separate and purify relevant compounds of interest contained in the lunar regolith simulant.

DITA

Student Presentation Abstracts

PIRAT: A Framework for Determining Cryptoperiods in OPC UA Groups

Gabriele Cianfarani

Oral presentation

Security is key when designing IoT systems and a cornerstone of IoT security is cryptography. This presentation introduces PIRAT, a framework for determining the cryptoperiod of OPC UA groups. PIRAT incorporates security requirements, communication data, and threat models derived from databases such as MITRE ATT&CK to calculate the optimal cryptoperiod. This ensures that cryptographic keys are updated frequently enough to satisfy a risk tolerance threshold specified by an operator without causing unnecessary disruptions to the system. Although the framework is still in its early stages, it has the potential to provide a systematic and data-driven approach to determining cryptoperiods.

Automated Anomaly Remediation for Cloud-native Applications

Komal Sarda

Poster presentation

This research focuses on addressing issues related to anomaly detection, fault prevention, and remediation in large-scale shared cloud environments. Cloud outages can be caused by various factors such as resource exhaustion, deployment misconfigurations, and software bugs that spread beyond the faulty application or micro-service. Interference effects, which result from the unforeseen influence of applications on each other, have made it more difficult to address these issues. The research aims to automatically detect interference effects, distinguish between anomalies caused by interference, and identify their root causes. Additionally, it seeks to determine the effectiveness of injected faults in the interference detection model, identify the "gold metrics" for transfer learning, and develop a framework for semi-automatically creating runbooks for unseen anomalies.

DetectON: An Online Framework to Automatically Detect Performance Anomalies on Cloud Native Applications

Mohammadreza Rasolroveicy

Oral presentation

In recent years, cloud computing has experienced rapid growth, revolutionizing how data is stored and processed. As businesses and organizations increasingly rely on these services, maintaining the stability, reliability, and integrity of cloud systems has become paramount. Traditional perimeter-based approaches have proven insufficient in addressing modern cloud computing environments' complex, interconnected nature. To enhance the integrity and optimize system performance, this study proposes to investigate the role of anomaly detection in identifying and addressing potential performance bottlenecks, and resource allocation issues. The first research question focuses on automatically identifying and differentiating the impact of concurrent multiple anomalies and high workloads on microservices performance, in this section, we identify what are the most important metrics that can help us predict an upcoming system failure. The second research question investigates the automatic detection of interference effects and the determination of root causes for anomalies originating from faults in target containers or interference from other containers in the microservice. Through our investigation, we seek to contribute to the development of effective anomaly detection techniques, ultimately leading to improved system performance in cloud computing environments.