The Canadian Academy of Engineering | L'Académie canadienne du génie

CAE Annual Conference

May 27-29, 2024

Western University, London, Ontario

Conference Co-Chairs: Jesse Zhu and Catherine Karakatsanis

Local Program Co-Chairs: Jesse Zhu, Andy Hrymak and Ying Zheng

Fellows' Showcase

May 27, 2024

Organizers: Ying Zheng, Sarah Shortreed, and Miriam Capretz

Monday, May 27th

Time	Description	Location
12:30-1:30pm	Networking Luncheon	Western, ACEB 1410
1:30-4:00pm	Fellows' Showcase Workshop Session 1 Session 2	Western ACEB 1415 ACEB 1420
4:00-5:00pm	Ontario Section	Western, ACEB 1415

ACEB – Amit Chakma Engineering Building, located on the east side of Western Road, opposite to Richard Ivey Building @ 1255 Western Road

Session 1: Clean Energy & Materials Technologies **Location: ACEB 1415**, Western University, London, Ontario, Canada				
	13:30-13:40	Session Chair: Sarah Shortreed, FCAE, ICD.D Welcome Message: Ying Zheng, Program Co-Chair, FCAE, FEIC, Western University		
1	13:40-13:50	Yun Hang Hu	Michigan Technological University	Super-structured Materials for Energy Devices
2	13:50-14:00	Bruce Taylor	Enviro-Stewards Inc.	Credible Affordable Decarbonization
3	14:00-14:10	Kamiel Gabriel	Ontario Tech University	Scalable Low-Carbon Hydrogen Production Technology Utilizing Waste/Process Heat
4	14:10-14:20	James Chen	Natural Resources Canada	Recent Progress in Laser Materials Processing: From Welding, and Additive Manufacturing to Battery Recycling
5	14:20-14:30	Shuhui Sun	INRS	Next Generation Battery and Hydrogen Technologies for a Carbon-Neutral Future
6	14:30-14:40	Elizabeth Gillies	Western University	New Approaches Towards Controlling Polymer Degradation
7	14:40-14:50	Hesham El Naggar	Western University	Innovative Foundation for Wind Turbines
8	14:50-15:00	Jun Long	Suncor Energy (Syncrude) Operating Inc.	Responsibly Developing the Oil Sands Resource through Technological Innovations
9	15:00-15:10	Franco Berruti	Western University	Biocarbon: The Most Effective Solution for Carbon Sequestration
10	15:10-15:20	Marilyn Spink	GS Group	Accelerating Canada’s Critical Material Supply Chains
11	15:20-15:30	Wenli Duo	FPInnovations	Control of Air Pollutants and Reduction of Carbon Emissions for Pulp and Paper Industry
12	15:30-15:40	Fenglou Zou	Volta Energy	On the Way to Circular Carbon-Based Energy

Session 2: Artificial Intelligence (AI), Hardware & Computing Science **Location: ACEB 1420**, Western University, London, Ontario, Canada				
	13:30-13:40	Session Chair: Miriam Capretz, Associate Dean-Research, Western University Welcome Message: Jesse Zhu, FCAE, FEIC, FRSC, Conf. Co-Chair, Western University		
1	13:40-13:50	Baochun Li	University of Toronto	Generative AI and Distributed Machine Learning
2	13:50-14:00	Hugh Liu	University of Toronto	Autonomous Drone Flight: Where are We?
3	14:00-14:10	Frederic Coulombe	Jericho Lab	Creating a New Paradigm in Open-Source Hardware
4	14:10-14:20	Jie Liang	Simon Fraser University, AltumView Systems Inc.	Privacy-Preserving Activity Sensor for Senior Care and Remote Patient Monitoring
5	14:20-14:30	Steve Hranilovic	McMaster University	Optical Wireless Communications: Bridging Canada's Digital Divide
6	14:30-14:40	Joshua Pearce	Western University	Systems Engineering with the Free Appropriate Sustainability Technologies (FAST) Lab
7	14:40-14:50	Slobodan P. Simonovic	Western University	Rainfall Intensity Duration Frequency Curves for Future Climate Scenarios: A Publicly Accessible Computer Tool IDF_CC
8	14:50-15:00	Ajay Ray	Western University	Innovative Design of Simulated Moving Bed Systems for Purification of Pharmaceutical Drugs
9	15:00-15:10	Claude Lague	University of Ottawa	Controlled-Traffic Farming (CTF) in Production Agriculture
10	15:10-15:20	Liang Song	Fudan University	Online Evolutive Learning towards a Networked AGI
11	15:20-15:30	Phalguni Mukhopadhyaya	University of Victoria	A Novel Approach to Quantify Infrared Thermography Images for Energy Audit of Exterior Building Envelopes
12	15:30-15:40	Wenjun (Kevin) Zeng	Eastern Institute of Technology	Interpretable and Controllable AI Generated Content
13	15:40-15:50	Qiao Sun	University of Calgary	Towards building digital twins for prognostics and health management (PHM) of industrial assets

Session 1: Clean Energy & Materials Technologies

1-1 Super-structured Materials for Energy Devices

Yun Hang Hu

Department of Materials Science and Engineering, Michigan Technological University, Houghton, MI 49931, USA

The advancement of energy devices hinges greatly on materials innovation. Recently, Prof. Hu's research group invented novel superstructured materials, opening a new door for energy device development and environmental remediation. In this talk, Prof. Hu will spotlight these recent breakthroughs, notably:

(a) The Carbonate-Superstructured Solid Fuel Cell (CSSFC): In innovative cell, the in-situ formation of superstructured carbonate on a solid metal oxide created a distinctive liquid-solid interface that acts as an ultrafast conduit for oxygen ion transfer, resulting in an unparalleled high Open Circuit Voltage (OCV) and remarkable peak power density when fueled by methane at 550 °C *(PNAS* 2024, 121, e2314996121; *PNAS* 2022, 119, e2208750119).

(b) Superstructured $NiMoO_4$@$CoMoO_4$ Core-Shell Nanofiber Arrays on Mo-Transition-Layer-Modified Nickel Foam (NF) Current Collector: This configuration represents an efficient electrode design for supercapacitors. It combines highly conductive $CoMoO_4$ with electrochemically active $NiMoO_4$, leveraging a synergistic effect and thus achieving an exceptional areal capacitance of 10.0 F/cm^2 (*PNAS* 2023,120, e2219950120).

Bio: Prof. Yun Hang Hu made seminal contributions to advanced catalysts, novel materials and innovative processes for clean energy and renewable energy. His collaborations with Canadian universities created a new direction not only for heterogeneous catalysis but also for the utilization of solar energy and greenhouse gases, which is truly important for Canada. As a world-renowned leading expert in energy materials and processes, he was recognized with numerous prestigious honors and awards including election to Fellow by six major societies (AAAS, ACS, APS, AIChE, ASM International, and RSC) and the Rudolf Erren Award from the International Association for Hydrogen Energy.

1-2 Credible Affordable Decarbonization

Bruce Taylor

Enviro-Stewards Inc., London, Ontario, Canada

Academic, manufacturing and commercial organizations are making commitments to achieve specific sustainability targets, but many (or most) do not have credible plans to do so.

This workshop outlines a proven approach for small, medium and large organizations to reach these goals soon, while increasing their net profitability. Learn how Maple Leaf foods became the World's First Carbon Neutral Major Food Company (while saving $17 million). Or detailed & affordable capital plans developed for seven Unilever facilities to reach zero emissions from their operations by 2030. Finally, learn credible & equitable ways to address remaining balances following deep conservation measures.

Bio: Bruce is a fellow of the Canadian Academy of Engineering and founded Enviro-Stewards, which is a Best for the World classified B Corporation and the only Canadian company to win a Global SDG award. Ten of their engineering projects have won national sustainability awards, including helping Maple Leaf Foods reach net zero emissions (while saving money) and helping 50 Canadian Food & Beverage processors to reduce food loss by $240,000/yr each (link). Bruce also founded the safe water social venture project that was featured in B the change magazine,MEDA magazine, a TEDx talk, and a short documentary (Ngongakinda). SDG rich projects such as these provide an equitable opportunity for the last mile of facility's journeys to achieve their carbon commitments.

1-3 Scalable Low-Carbon Hydrogen Production Technology Utilizing Waste/Process Heat

Kamiel S. Gabriel

Ontario Tech University, Oshawa, ON, Canada

Achieving net-zero emissions requires a radical transformation in the way we produce, supply, transform and use energy. The rapid growth of wind, solar and electric cars has shown the potential of how new clean energy technologies can bring down emissions.

Reaching net-zero emissions in 2050 would require a much more rapid deployment of low-carbon power generation. But electricity cannot decarbonize entire economies alone. Hydrogen forms a bridge between the power sector and industries. In fact, Hydrogen and CCUS account for about half of cumulative emissions reductions in the steel, cement, and chemicals sectors. In the trucking, shipping and aviation sectors, use of alternative fuels – hydrogen, synthetic fuels, and biofuels – ranges between 55% and 80%.

Earlier analysis of future energy pathways shows that it is technically possible to achieve improved energy access, air quality, and energy security simultaneously while avoiding dangerous climate change. In fact, a number of alternative combinations of resources, technologies, and policies are found capable of attaining these objectives.

Although a successful transformation is found to be technically possible, it will require the rapid introduction of policies and fundamental political changes toward concerted and coordinated efforts to integrate global concerns, such as climate change, into local and national policy priorities such as health and pollution, energy access, and energy security.

Bio: Dr. Gabriel is the founding Associate Provost, Research & Graduate Programs at the University of Ontario Institute of Technology. He has been instrumental in rapidly moving UOIT into a culture of research intensiveness. His tireless efforts led to UOIT being widely respected in the academic community and among stakeholders in governments, industry and the public at large. Dr. Gabriel is an internationally renowned researcher. He is specially known for his pioneering work in the area of thermal management systems for space applications. He holds a US patent for a heat-recovery system which regains over 60% of heat from exhaust waste air and recycles it back to buildings. Dr. Gabriel is the co-founder of the Durham Strategic Energy Alliance (DSEA) which leads energy initiatives in the Durham region.

1-4 Recent Progress in Laser Materials Processing: From Welding, and Additive Manufacturing to Battery Recycling

James Chen

CanmetMATERIALS, Natural Resources Canada

Laser materials processing, a cornerstone of modern manufacturing for decades, continues to drive significant advancements in the industry and economy. This presentation will showcase recent breakthroughs in several key areas: (1) laser-arc hybrid welding for pipelines, enhanced by a novel wobbling laser technique and wire addition; (2) a groundbreaking no-preheat laser additive manufacturing process developed for submarine life extension; and (3) state-of-the-art advancements in laser additive manufacturing via direct energy deposition. Furthermore, our most recent work on recycling lithium-ion batteries with laser technology will be briefly highlighted.

Bio: Dr. James Chen, a senior research scientist at Natural Resources Canada, is recognized for spearheading groundbreaking laser additive manufacturing repairs to extend the life of Royal Canadian Navy submarines, and for his innovations in laser materials processing and advanced welding technologies, which have led to commercial success and global leadership.

1-5 Next Generation Battery and Hydrogen Technologies for a Carbon-Neutral Future

Shuhui Sun

INRS, Canada

In this talk, Professor Sun will introduce his work on the following aspects:

(1) Advancements in high-performance electrode materials and electrolytes for High-Energy-Density, Long-Life Li-Metal Batteries and Rechargeable Metal-air batteries. Specifically, we developed a patented electrolyte additive strategy to prevent lithium dendrite growth on Li metal anode. This innovation is pivotal for producing safer, longer-lasting and higher-voltage lithium metal batteries.

(2) Development of Low-Pt and Pt-free catalysts for hydrogen Fuel Cells. Particularly, the activity of our Fe-based catalyst has reached that of state-of-the-art commercial Pt catalysts.

(3) Exploration of Single-atom catalysts (SACs) and non-precious metal catalysts for green H_2 Production. Particularly, our non-precious metal-based catalysts have demonstrated exceptional performance in freshwater and seawater splitting at high current densities (e.g. 500 mA cm^{-2}).

Bio: Dr. Shuhui Sun is a Fellow of the Canadian Academy of Engineering (CAE), and a Full Professor at the Institut National de la Recherche Scientifique (INRS), center for Energy, Materials, and Telecommunications (Montreal, Canada). He is also a member of the Royal Society of Canada (College), and the Vice President of the International Academy of Electrochemical Energy Science (IAOEES). He serves as the Executive Editor-in-Chief of *Electrochemical Energy Reviews* (EER, IF=31.3), Associate Editor of *SusMat* (IF=28.4), and editorial board member of over 10 journals. His research interests focus on Nanomaterials for Clean Energy Conversion and Storage applications, including H_2 fuel cells, hydrogen generation, lithium batteries, Metal-air batteries, Na-ion/Zn-ion batteries, CO_2 reduction, etc. He has published over 300 articles in peer-reviewed, high-impact journals, including *Nature Sustainability*, *Nature Communications, Science Advances, Energy & Environmental Science, Advanced Materials, Advanced Energy Materials, J. Am. Chem. Soc., Angew. Chem, etc*. He has edited 5 books and 16 book chapters, and holds 6 US patents. He has built extensive collaborations with industry partners.

1-6 New Approaches Towards Controlling Polymer Degradation

Elizabeth R. Gillies

Department of Chemical and Biochemical Engineering, Department of Chemistry, School of Biomedical Engineering

The University of Western Ontario, 1151 Richmond St., London, ON, N6A 5B9, Canada

Degradable polymers are of interest across a wide range of fields from commodity plastics to medicine. Progress has been made to date with conventional degradable polymers. However, the ability to control their degradation is limited and they may degrade prematurely, leading to poor performance or too slowly, leading to microplastic pollution. This presentation will describe the development of degradable polymers that undergo depolymerization upon cleavage of an end-cap in response to a specific stimulus, such as light, heat, or pH change. Progress towards the application of these polymers in different areas such as micropatterning and therapeutic delivery will be presented.

Bio: Elizabeth Gillies is an international leader in the development of new designs to control the degradation of polymers. She developed a new class of polymers that unzip upon stimulation by light, heat, pH, or redox change. These unique polymers are currently being applied to release drugs at specific sites in the body, as traceless inks for 3D printing, and as replacements for conventional non-degradable plastics. She has mentored > 110 trainees, and published 142 papers with > 9600 citations. She received an NSERC EWR Steacie Fellowship, Canada Research Chair, membership in the RSC College, and two Engineering Teaching Awards.

1-7 Innovative Wind Turbine Foundations

M. Hesham El Naggar

Western University, London, ON, N6A 5B9, Canada

Green energy resources are essential to meet the world growing energy demands while reducing the effects of global warming. Wind energy being one of the main efficient renewable energy sources, drives the ever-increasing expansion of both onshore and offshore wind farms globally. In addition, wind energy technologies are improving and wind turbines capacity continues to grow, making energy production more affordable. For example, new offshore wind turbine projects with capacity more than 315GW will be added over the next decade (2022-2031), which will result in total offshore wind energy of 370GW by 2031 (Global Wind Energy Council, 2022). However, one of the main challenges for wind projects is the cost of foundation construction, especially for offshore installations, which can be as high as 40% of the total cost. This presentation discusses recent developments in sustainable design of foundations for wind turbine foundations, both onshore and offshore.

Bio: Dr. Hesham El Naggar is a Distinguished University Professor at Western University. He is an internationally acclaimed scholar in the fields of foundation dynamics, deep foundations, and geotechnical earthquake engineering. He advanced the state-of-the-art in analysis and design of foundations for dynamic loads. His innovative wok on foundation dynamics led to the development of DYNA6, the industry standard in machine foundation design. His work on foundation design and geotechnical earthquake engineering has been incorporated into design guidelines recommended by regulatory bodies and learned societies.

1-8 Responsibly Developing the Oil Sands Resource through Technological Innovations

Jun Long

Research and Development, Suncor Energy (Syncrude) Operating Inc.

With estimated reserves of ~164 billion barrels, the Canadian oil sands are among the largest oil deposits on the planet. To secure Canada's energy future, Syncrude has been a pioneer in developing this resource responsibly through technological innovations. One example is the development and application of the Secondary Process Aids (SPA) technology. This technology enables the processing of low-grade ores at higher production rates and lower costs while reducing environmental impact. It has been successfully applied at Syncrude and Suncor Energy, generating significant value to the industry. It represents one of the major innovative technologies that Syncrude developed for oil sands processing.

Bio: Dr. Long is a world-leading expert in developing innovative technologies for effective recovery of bitumen from Canada’s massive oil sand resources. With 24 patents, his step-change inventions, most notably the Secondary Process Aids technology, resulted in revolutionary advances in oil sands processing, creating billions in value and helping secure Canada’s energy future by unlocking oil sands resources in a more efficient, sustainable, and environmentally responsible manner. Dr. Long also made substantive contributions to collaborative research and education in engineering through his initiatives and involvement in several NSERC Industry Research Chairs and CRD programs.

1-9 Biocarbon: The Most Effective Solution for Carbon Sequestration

Franco Berruti

Department of Chemical and Biochemical Engineering, Western University, Canada

Science should drive policies and regulations to ensure a sustainable (environmentally, socially and economically) green transition. Since 2015, which saw COP21 in Paris, Net Zero is a global target that must be rapidly accompanied by a Net Negative strategy to mitigating climate change. Accordingly, the role of biocarbon as a method for durable carbon removal is growing very quickly and gaining attention. We discuss the durability of the Carbon in biocarbon, and the need for analytical techniques to support stakeholders on a project level. The different ecologically relevant groups of carbon forms contained in biocarbon are introduced, and possible methods to assess the quality of the product versus the regulatory requirements about permanence of carbon removals are summarized. Biocarbon is today one the most doable solutions which can ensure very long-term removals, combined with co-benefits that are gaining relevance when mitigating climate impacts in agricultural soils.

Bio: Professor Berruti graduated in Chemical Engineering from the Politecnico di Torino (Italy) and achieved a PhD at the University of Waterloo (Canada). He started his career in Canada at the University of Calgary becoming a full professor in 1992 and Associate Dean (Research and Graduate Studies) in 1994. He served as Dean of Engineering at the University of Saskatchewan (1996-2000) and at the University of Western Ontario (2000-2008). He is the Founding Director of the Institute for Chemicals and Fuels from Alternative Resources (ICFAR). Dr. Berruti is an accomplished and internationally recognized researcher with expertise in chemical reactor technologies, thermal cracking, conversion of heavy oils and biomass residues and organic wastes into value-added fuels and chemicals.

1-10 Accelerating Canada's Critical Material Supply Chains

Marilyn Spink

GS Group

Canada prides itself on its minerals & materials research eco-system. However, its success leans more heavily on the Research in R & D. Canada fails to have equal success in Development. De-risking, scale-up and commercialization of promising research are imperatives to Canada's and the West's future economic security. The Energy Transition presents Canada with a generational opportunity to participate in the global demand for critical materials considering its natural & human resources, trade & collaborative relationships, innovation & research wealth. Adding value to our own raw materials, rather than enabling others to do so, will be dependent upon industry & engineering/technical leaders rising to these opportunities in collaboration with investors, government, and academia.

Bio: As an expert in metallurgical and mining processes, Marilyn Spink has managed the successful delivery of complex mine development projects throughout the world ranging in value from $US500M to 9B. In recognition of her illustrious career, in 2020, Marilyn was bestowed the prestigious United Kingdom WIM 100 Global Inspirational Women in Mining. In 2018, she was named a Canadian Institute of Mining Distinguished Lecturer and in 2017, the inaugural Ursula Franklin Memorial Lecturer for the University of Toronto. Marilyn has also served her profession as an Ontario Lieutenant Governor Appointee and Vice President to Professional Engineers Ontario Council.

1-11 Control of Air Pollutants and Reduction of Carbon Emissions for Pulp and Paper Industry

Wenli Duo

FPInnovations

FPInnovations is a not-for-profit forest institution with expertise in fibre supplies, wood products, pulp, paper, and bioproducts. Kraft pulping uses white-liquor containing NaOH+Na_2S. Black-liquor recovery boilers can be an emitter of total-reduced-sulfur (TRS) including H_2S. Kraft mills run lime kilns and biomass power boilers, too. Harmful emissions from such facilities, including TRS, SO_2, NO_x, HCl, CO, particulate, etc., must be reduced for mill's productivity. I have worked on control of air pollutants by applying high-temperature chemistry and through boiler optimization. Boilers burning salt-laden bark or demolition waste may generate toxic chlorinated dioxins and furans. Our successes reduced dioxin/furan emissions in British Columbia by 68%. Effective utilization of biomass is a key for the pulp-paper and other industries in Canada to achieve low carbon emissions. Collaborating with its members and partners, FPInnovations has developed technologies for production of biomaterials and bioenergy, valorization of waste streams, decarbonization of production processes, etc.

Bio: Dr. Wenli Duo, Principal Scientist at FPInnovations, has research-developed and implemented innovative technologies to improve industrial practices including facility operations. He is a distinguished expert in high temperature engineering chemistry that has allowed breakthrough achievements in control of pollutants NOx, SO2, HCl, etc., power/recovery boiler optimization, and process debottlenecking. His work in biomass energy has positively impacted Canadian and international pulp-paper industries with $60M benefits and 180kt CO2 reduction per year and lowered 68% emissions of toxic dioxins/furans in British Columbia. He received I.W. Weldon Award and Douglas Jones Environmental Award from PAPTAC, and CSChE Award in Design and Industrial Practice.

1-12 On the way to circular carbon-based energy

Fenglou Zou

Volta Energy

Volta Energy is dedicated to build core enabling technologies for an energy transition towards a Net-Zero future. Staffed by engineers, scientists, and technicians at the forefront of their respective fields, we represent a perfect blend of knowledge, experience, focus, and innovation. Since our inception 2009, we have been ahead of the curve in thinking about sustainability and have achieved success in creating solutions which are practical, implementable, and can be scaled up. Our newest venture represents our foray into the Renewable Energy space and includes projects focused on Carbon Neutral Drop-in fuels, SOC technology, and Natural Gas Value Addition.

Bio: Dr. Zou is the Principal Researcher with Volta Energy

Session 2: Artificial Intelligence (AI), Hardware & Computing Science

2-1 Generative AI and Distributed Machine Learning

Baochun Li

Department of Electrical and Computer Engineering, University of Toronto, Canada

Professor Li introduces two of his recent projects related to this research direction of generative AI and distributed machine learning. I will first present some of our recent advances towards addressing the challenge of fine-tuning large language models with private data, and introduce Titanic, a new distributed training paradigm that allows LLMs to be fine-tuned in a privacy-preserving fashion directly on the client devices where private data is produced, while operating within the resource constraints on computation and communication bandwidth. The key idea of Titanic is to partition an LLM across multiple client devices, so that it can be fine-tuned with no or minimal losses in training performance. In designing Titanic, we focused on its feasibility in real-world systems, and implemented a model-agnostic partitioning mechanism that is fully automated. In the second project, I will briefly present our recent work on the use of multiple cloud platforms to perform distributed machine learning across clouds. This preserves the privacy of data as we ship training workloads to where data resides. We envision a high-speed overlay network atop datacenters and clouds, capable of relaying data across multiple paths while reacting nimbly against network changes with optimized policies.

Bio: Prof. Baochun Li is an internationally renowned researcher and technology innovator in multimedia systems, networking, cloud computing, and distributed systems. As the Bell Canada Endowed Chair, he has developed the world's first large-scale deployment of network coding in commercial media streaming systems. Working closely with industry partners such as Bell Canada and Microsoft, his published papers, many of which are highly cited, have attracted over 23000 citations with an H-index of 84. He is an IEEE Fellow, played leadership roles towards automating review assignments in flagship IEEE conferences, and received numerous awards acknowledging his pioneering contributions in network coding systems.

2-2 Autonomous Drone Flight: Where are We?

Hugh Liu

University of Toronto Institute for Aerospace Studies (UTIAS)

Flight Systems and Control Research Group

Centre for Aerial Robotics Research and Education (CARRE)

Autonomous flight of unmanned aerial systems (UAS), or drones, has attracted much attention for its potential applications in various areas. In this showcase workshop presentation, we will highlight several use case research projects covering different domains, including autonomous drone delivery, autonomous environmental inspection, and autonomous drone racing. We will share our own perspectives regarding the future development of autonomous drone flight.

Bio: Hugh Liu, Professor of UTIAS, Flight Systems and Control Research Group www.flight.utias.utoronto.ca. Director of Centre for Aerial Robotics Research and Education (CARRE) www.carre.utoronto.ca. Dr. Hugh Liu is an internationally renowned researcher in aircraft systems and control. His research has been patented and applied by industry and has also led to a start-up company. A leader in his professional community, Dr. Liu serves on editorial boards of leading journals and technical committees of international societies. He is a Fellow of the Canadian Society for Mechanical Engineering and the Engineering Institute of Canada and an Associate Fellow of the Canadian Aeronautics and Space Institute and the American Institute of Aeronautics and Astronautics.

2-3 Creating a New Paradigm in Open-Source Hardware

Frederic Coulombe

Jericho Lab

At Jericho Lab, we specialize in developing low-cost, high-quality sensors and data loggers tailored for researchers managing budget-constrained or large-scale experiments (+100 sensors). Our mission is to democratize access to scientific tools, thus accelerating progress on key global challenges like climate change and economic development. Our expanding product line includes 8 sensor types like temperature sensors, current meters and thermal cameras, supported by a new business model that combines open-source hardware, AI tools, decentralization and minimalism. We invite you to participate in our survey to prioritize which sensors we develop next; your input will directly guide our development priorities, ensuring we focus on the tools that matter to you."

Bio: Frederic Coulombe, B.Eng., M.Sc.A. CEO and Founder of Jericho Lab. Frederic holds a mechanical engineer bachelor degree from Université de Sherbrooke (Canada) and a Master in Applied Science from Ecole de Technologie Superieure (ETS, Montreal), with a concentration in Energy Efficiency and Renewable Energy. Before Jericho, Frederic has worked as a university lecturer and as an analyst in the energy sector. Climate change is among his favorite topics since 1998, when he received his first science magazine. He voluntary pays to offset his personal carbon emissions since 2016.

2-4 Privacy-Preserving Activity Sensor for Senior Care and Remote Patient Monitoring

Jie Liang

School of Engineering Science, Simon Fraser University

AltumView Systems Inc.

In this talk, we will present the privacy-preserving smart activity sensor for senior care and remote patient monitoring developed by AltumView, a company co-founded by Professor Jie Liang at Simon Fraser University. It was a CES 2021 Innovation Awards Honoree, and is one of only three fall detection devices in Amazon Alexa Together. The sensor uses an AI chip to monitor the activities of people, collect health statistics, and notify caregivers in case of emergencies. To protect the privacy, only stick figures are transmitted instead of videos. We will also discuss the potentials of using large-model AIs in the system.

Bio: Prof. Jie Liang is an internationally renowned researcher in image and video compression. His research results have been adopted by industrial products and international standards such as Microsoft Windows Media Video Player and Blu-ray Disc. He made lasting contributions to the graduate program of School of Engineering Science at Simon Fraser University (SFU), and received the SFU Leadership Award. He has been the President of AltumView, leading the development of a smart sensor system to tackle the global aging population challenge. The product was selected by CES as an Innovation Award Honoree and by Amazon to integrate into Alexa Together.

2-5 Optical Wireless Communications: Bridging Canada's Digital Divide

Steve Hranilovic

Department of Electrical & Computer Engineering, McMaster University, 1280 Main St. West., Hamilton, ON L8S 4L8, Canada

Due to the increasing scarcity of RF spectrum and growing interference due to multiple users, deploying next generation high-speed wireless networks is becoming increasingly difficult. The use of unlicensed optical bands for wireless communications has been heralded as an exciting development for future broadband access for indoor, over long distances terrestrially, underwater and for space communication links. In a Canadian context, space-to-Earth laser satellite communication links are seen as particularly attractive to distribute broadband content to remote and rural communities bridging the digital divide.

Bio: Steve Hranilovic received the B.A.Sc. degree with honours in electrical engineering from the University of Waterloo, Canada in 1997 and M.A.Sc. and Ph.D. degrees in electrical engineering from the University of Toronto, Canada in 1999 and 2003 respectively. He is a Professor in the Department of Electrical and Computer Engineering, McMaster University (Hamilton, Ontario, Canada) where he currently serves as the Vice-Provost and Dean of Graduate Studies. During 2010-2011 he spent his research leave as Senior Member, Technical Staff in Advanced Technology for Research in Motion, Waterloo, Canada. His research interests are in the areas of free-space and optical wireless communications, digital communication algorithms, and electronic and photonic implementation of coding and communication algorithms. He is the author of the book Wireless Optical Communication Systems (New York:Springer, 2004). Dr. Hranilovic is a Fellow of the IEEE and of Optica, a Fellow of the Canadian Academy of Engineering and is a licensed Professional Engineer in the Province of Ontario. In 2016 the title of University Scholar was conferred upon him by McMaster University. He has served as an Associate Editor for the Journal of Optical Communications and Networking and an Editor for the IEEE Transactions on Communications in the area of Optical Wireless Communications.

2-6 Systems Engineering with the Free Appropriate Sustainability Technologies (FAST) Lab

Joshua M. Pearce

Department of Electrical & Computer Engineering, Ivey Business School, Western University, London, ON, Canada

The FAST lab specializes in solar photovoltaics (PV) and resilient food using open source hardware engineering. FAST is bringing the concept of agrivoltaics to Canada (co-locating PV and agriculture to increase land use efficiency and yield) including agrivoltaic agrotunnels (high-efficiency hybrid hydroponics/aeroponic indoor vertical growing). FAST is combining PV, heat pumps and thermal batteries to improve residential energy performance. FAST is using PV to power a system of AEM electrolyzers and plasma reactors to produce hydrogen from waste water and methane, respectively. The waste water is cleaned in an photo-bioreactor with microalgae that scavenge carbon dioxide and can be used as a food source or converted to plastic for additive manufacturing.

Bio: Dr. Pearce is a world-leading expert in three fields that are critical to sustainability. In solar photovoltaic (PV) technologies, he has demonstrated lower-cost source of power and dual-use benefits in agriculture (agrivoltaics), floatovoltaics, and solar in the built environment. He founded the field of free and open source hardware for science and engineering, which radically accelerates innovation while reducing research costs. He also founded the field of distributed recycling and additive manufacturing, which solves waste issues while enabling individuals to make products for themselves at lower costs. He has more than 400 peer-reviewed publications with more than 27,000 citations.

2-7 Rainfall Intensity Duration Frequency Curves for Future Climate Scenarios: A Publicly Accessible Computer Tool IDF_CC

Slobodan P. Simonovic

Department of Civil and Environmental Engineering, Institute for Catastrophic Loss Reduction, The University of Western Ontario, London, Ontario, Canada N6A 5B9

Rainfall Intensity Duration Frequency (IDF) curves are among the essential datasets used in water resources management across the globe. Traditionally, they are derived from observations of historical rainfall under the assumption of stationarity. Change of climatic conditions makes use of historical data for the development of IDFs for the future unreliable, and in some cases, may lead to underestimated infrastructure designs. The IDF_CC tool is designed to assist water professionals and engineers in producing IDF estimates under changing climatic conditions. The latest version of the tool (Version 7) provides updated IDF curve estimates for gauged locations (rainfall monitoring stations) and ungauged sites using a new gridded dataset of IDF curves for Canada's land mass. The tool has been developed using web-based technologies and takes the form of a decision support system (DSS). It is available at www.idf-cc-uwo.ca.

Bio: Slobodan P. Simonovic, Ph.D, P.Eng, Fellow of CSCE, ASCE and IWRA, D.WRE. Fellow of Royal Society of Canada. Fellow of Canadian Academy of Engineering. Professor Emeritus, Department of Civil and Environmental Engineering, Director of Engineering Studies, Institute for Catastrophic Loss Reduction, The University of Western Ontario, London, Ontario, Canada.

2-8 Innovative Design of Simulated Moving Bed Systems for Purification of Pharmaceutical Drugs

Ajay Ray

Department of Chemical and Biochemical Engineering, Western University, 1151 Richmond Street, London, ON, Canada N6A 3K7

Simulated Moving Bed (SMB) is a large-scale continuous version of the traditional batch High-Performance Liquid Chromatography (HPLC) used to separate mixtures of compounds that are difficult using traditional separation techniques. SMB systems can also be integrated to include reactions, which can provide economic benefit for equilibrium-limited reversible reactions. The inherent process intricacy in SMB mimics countercurrent movement between two phases and offers numerous advantages including increased productivity with high purity and lower solvent consumption. New innovative design and optimal operation helps to produce economically pure pharmaceutical drugs satisfying stringent product quality requirement while addressing safety issues and environmental concerns.

Bio: Ajay Ray is an internationally renowned researcher, leader, educator, and mentor in chemical engineering. He has made seminal research contributions in the field of solar photocatalysis, moving bed technology and optimization. His applied research ranges from synthesis of novel eco-friendly materials for renewable energy, and clean potable water, devising innovative approaches of process intensification for purification of biologics, and application of multi objective optimization in the improvement of industrial chemical processes. His research resulted in a deep understanding of technologies for applications in energy, environment, food, health, and water, the humanity’s most important challenges for next generation.

2-9 Controlled-Traffic Farming (CTF) in Production Agriculture

Claude Lague

University of Ottawa

Professor Lague will present his past and on-going R&D and engineering work related to Controlled-Traffic Farming (CTF) in production agriculture and to the use of agricultural Wide-Span Implement Carriers (WSIC) for the practical implementation of CTF. I am putting the 'finishing touches' to two MS PowerPoint reports that have a particular focus on the use of WSIC in cranberry production.

Bio: Claude Lague, Professor, Faculty Coordinator for Continuing Education and Professional Development, University of Ottawa. P.Eng. (Ontario); ing. (Québec). Fellow of Canadian Academy of Engineering. Fellow of Engineers Canada. As an agricultural engineer, Claude Laguë has made unique contributions to the development of agricultural machinery and to agricultural engineering education. He developed and validated the Wide-Span Implement Carrier (WSIC) concept as an alternative to traditional agricultural field machinery systems. As an academic leader at three Canadian universities, Dr. Laguë has been a tireless promoter of engineering entrepreneurship. Since 2006, he has led paradigm-shifting change in the Faculty of Engineering of the University of Ottawa, making it one of the most graduate student-intensive engineering faculties in Canada. Dr. Laguë is also serving on the boards of directors of not-for-profit organizations that serve the engineering profession.

2-10 Online Evolutive Learning towards a Networked AGI

Liang Song

Academy for Engineering & Technology, Fudan University, China

The talk highlights Online evolutive learning (OEL), which is a learning method to achieve online model optimization of individual intelligences in a multi-agent environment based on the interaction and fusion of multi-intelligence on sensing, controlling, and generating information, and autonomously adapting to time-varying environmental characteristics based on the constraints of intelligent environments, as well as achieving networked General Artificial Intelligence (AGI).

Bio: Dr. Liang Song is a world-class engineer and entrepreneur in smart wireless systems, an emerging area of artificial intelligence (AI) and next-generation wireless systems. Due to his contributions in both L2 cognitive multi-hop wireless networks and distributed AI, large-scale and ubiquitous smart infrastructure can be possible, by interconnecting smart terminals with data sensing, wireless communications, and processing. His work represented Canada in 5G telecommunications, impacting all cellular subscribers; and is leading the development of global smart infrastructure. Dr. Song has received world-wide recognitions, and mentored over fifty graduate students, younger researchers and business managers/executives partly through his honorary professorships.

2-11 A Novel Approach to Quantify Infrared Thermography Images for Energy Audit of Exterior Building Envelopes

Phalguni Mukhopadhyaya

University of Victoria

Buildings are responsible for about 18% of Canada's greenhouse gas emissions. Most of the buildings in service today were built before stringent building energy codes were in place. During the last two decades, several codes, regulations, and rating systems have been developed for making new constructions more energy-efficient with a low carbon footprint, but existing buildings need to be retrofitted too. To make our existing buildings more energy efficient, an energy audit of exterior building envelopes is a necessary first step. This presentation will demonstrate a novel approach to quantify infrared thermography images for energy audits of exterior building envelopes.

Bio: Professor Phalguni Mukhopadhyaya's research activities in the areas of novel construction materials, material testing, and innovative design for building envelopes and structures are ground-breaking and transformative for the stakeholders of the construction industry. He has produced seminal research outputs and applied them to solve many practical engineering problems. Throughout his career, he has demonstrated an exceptional ability to identify and find solutions for the infrastructure challenges faced by society and transfer his knowledge to stakeholders in a thoughtful style through the development of construction standards/codes/guidelines, organization of seminars/conferences, and collaboration with industry partners.

2-12 Interpretable and Controllable AI Generated Content

Chair Professor

Eastern Institute of Technology, Ningbo, China

With the rapid development of Artificial General Intelligence, AI generated content (AIGC) technologies such as ChatGPT/Sora have demonstrated strong perception and generation capabilities. However, it remains underexplored how to realize interpretable and controllable AI such that the AI generated contents are reliable and trustworthy thereby effectively facilitating their applications. In this talk, we first discuss the concept of interpretable AI, highlighting the importance of clear semantics of AI models and interpretable process of content generation. We also discuss the importance of controllability in AI content generation, and the future trends.

Bio: Wenjun (Kevin) Zeng has been a Chair Professor and Vice President for Research of the Eastern Institute of Technology (EIT), Ningbo, China since Oct. 2021. He is also the founding Executive President of the Ningbo Institute of Digital Twin (IDT). Prior to that, he was a Sr. Principal Research Manager and a member of the Senior Leadership Team at Microsoft Research Asia where he was leading the video analytics research powering the Microsoft Cognitive Services, Azure Media Analytics Services, Microsoft Office, Dynamics, and Windows Machine Learning. He was a professor with the Computer Science Dept. of Univ. of Missouri from 2003 to 2016. Prior to that, he worked for PacketVideo Corp, San Diego, CA, Sharp Labs of America, Camas, WA, Bell Labs, Murray Hill, NJ, and Panasonic Technology, Princeton, NJ. He has contributed significantly to the development of international standards (ISO MPEG, JPEG2000, and Open Mobile Alliance). He received his B.E., M.S., and Ph.D. degrees from Tsinghua Univ., the Univ. of Notre Dame, and Princeton Univ., respectively. He is on the Editorial Board of International Journal of Computer Vision, and was an Associate Editor-in-Chief, Associate Editor, or Steering Committee Member for a number of IEEE journals. He has served as the General Chair or TPC Chair for several IEEE flagship conferences (e.g., ICME'2018, ICIP'2017). He is a Fellow of the IEEE and a Fellow of CAE.

2-13 Towards building digital twins for prognostics and health management (PHM) of industrial assets

Professor and Head

University of Calgary

In this presentation, I will report our research endeavors in machine dynamics analysis and its pivotal role in health condition monitoring and fault diagnosis, with a specific emphasis on its applications to wind turbines. While data-driven methodologies have historically prevailed in this domain, leveraging advanced signal processing, data modeling, and machine learning techniques, our recent focus has been on taking a hybrid approach that integrates both physics-based principles and data-driven methodologies. This framework aims to enhance predictive capabilities in the realm of machine dynamics analysis. Through this presentation, I will showcase our latest developments and empirical findings in this interdisciplinary field.

Bio: Dr. Qiao Sun is a professor and department chair of Mechanical and Manufacturing Engineering at the University of Calgary, Canada. She is Fellow of Canadian Academy of Engineering. Previously, she was Senior Associate Dean at the Schulich School of Engineering in charge of Faculty-wide international initiatives. Dr. Sun's research is in the general area of dynamic systems modeling, fault diagnosis, and control. Her expertise ranges from multiple flexible robots coordinated control, inverse dynamics, stability, and optimal load sharing, to piezoelectric nonlinearity and feedforward compensation, wind turbine fault diagnosis and robust control, and physics informed advanced signal process and pattern recognition. Dr. Sun has won numerous awards in research, teaching, and professional service. Her students have won prestigious scholarships, best paper awards, and conference sponsorships at Canadian and international venues. As an academic leader, she works to build bridges, foster collaboration, and create inclusive spaces for all.