2025 iMerit Annual General Meeting

Details:

Friday, June 27, 2025

Westin Hotel & Resort

Book of Abstracts

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PhD Abstracts

Numerical analysis and validation of turning circle and zig-zag maneuvers of kriso container ship in calm sea using body force method

Adwaith Nath

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Abstract: 6DoF Unsteady-Reynolds-Averaged-Navier-Stokes (URANS) CFD simulations are conducted using the body-force propeller based on the Hugh & Ordway model with Goldstein Optimum distribution to study and validate maneuvering performance of KRISO container ship with appended rudder in calm sea. The cases studied are the 35˚ portside turning circle, 10˚/ 10˚ zig-zag starting to port, 20˚/ 20˚ zig-zag starting to port, and 20˚/ 20˚ zig-zag starting to starboard maneuvers. Before the maneuvers are executed, the rudder is brought to the neutral position using a PID controller control such that the yaw angle is zero to mimic the initial experimental conditions. The two-phase incompressible simulations are solved using the STAR-CCM+ CFD software. The hull and rudder are meshed as separate overset grids to allow the 6DoF motion of the hull and the deflection of the rudder. The time histories of the predicted ship trajectory, motion, orientation, and velocities are illustrated and validated against the experiments, along with a comparison of maneuvering-specific parameters. The comparisons show the use of the body-force propeller model is an efficient and effective method for ship maneuvering simulations.

Research Interests:

- Study of maneuvering of ships in waves using RANS
- Investigation of level-set method for maneuvering simulations

Hydrophone array measurements at the Endeavour Vent Field

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Abstract: Passive acoustic monitoring can be used at hydrothermal vent fields to detect changes in vent activity over time. This provides advantages over direct measurements because the caustic nature of vent fluid tends to degrade instruments quickly, while hydrophone measurements can be conducted from a safe distance. Both continuous and transient sounds are generated by hydrothermal vents, which can be detected by hydrophones in the proximity of vent fields. Evidence of both continuous and transient vent sounds have been measured at the Main Endeavour Field on the Juan de Fuca Ridge in the Northeast Pacific using hydrophone arrays operated by Ocean Networks Canada (ONC). Coherence measurements between hydrophone pairs are reported, showing some applications of array processing to continuous vent soundscape measurements. Beamforming is applied to the hydrophone array for transient sound analysis to estimate the direction and source of these signals. Array analysis is conducted for short-term deployments using the Deep Acoustic Lander hydrophone array as well as long-term measurements using ONC's volumetric hydrophone array.

Research Interests:

- Passive acoustical oceanography
- Hydrothermal vents
- Natural soundscapes

The contributions of ice-cracking and saltation to underwater ambient sound levels in landfast ice

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Abstract: Typically, wind-wave interactions dominate the natural underwater soundscape. However, in landfast ice-covered regions this mechanism no longer contributes to the soundscape as ice cover separates the atmosphere from the ocean. In these regions, ice will generate sound at the ocean surface with the influence of wind, temperature and tides. The mechanisms by which ice creates sound depends on the season and ice cover type. The wind contributes to the underwater soundscape in ice covered regions through saltation which is a mechanism where the wind carries ice and snow particles across the ice surface which generate underwater sound as the particles impinge on the ice surface, while ice cracking is usually thermally driven. As the air cools, the surface of the ice contracts and deforms. A seasonal ice observatory was established in Postville during the 2024 landfast ice season. The observatory measured various atmospheric, ice and ocean properties using ice deployed measurement systems such as wind speed, atmospheric temperature, short wave and long wave radiation, ice and ocean temperature profiles, ocean salinity profiles, ocean currents, snow depth and acoustic recordings. This project combines environmental data measured at the observatory with hydrophone measurements to understand the contribution of ice cracking and saltation to the ambient sound field. Ice cracking events are identified in the acoustic recordings and correlated with tidal velocity and temperature gradients. Broadband high frequency sound is correlated with wind velocity. The contribution of these mechanisms to the soundscape is discussed.

Research Interests:

- Underwater ambient sound in sea-ice covered regions
- Acoustic mechanisms of sea ice
- Anthropogenic noise in landfast ice
- Passive acoustic monitoring in coastal ice-covered regions
- Propagation of sound in ice covered regions

ClearNet: An Adversarial Dehazing Network for Robust Robotic Perception in Challenging Visual Conditions

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Abstract: Robotic perception systems are often challenged by visibility degradation caused by haze, fog, and other visual obstructions. These conditions reduce image contrast and obscure key features, impairing tasks such as navigation, mapping, and object detection. This project introduces ClearNet, a lightweight generative adversarial network (GAN) developed for single-image dehazing to enhance the reliability of robotic vision in such challenging scenarios. Trained on the RESIDE dataset and evaluated using standard metrics including PSNR and SSIM, ClearNet restores structural detail and improves overall image clarity. Though designed for terrestrial haze and fog, the approach is conceptually extendable to underwater environments, where scattering and absorption result in similar visibility degradation. Experimental results show that ClearNet can significantly enhance image quality and support a more robust downstream perception.

Research Interests:

- Robot Perception and Navigation
- Image and Signal Processing
- Advanced Control Algorithms

Development of a methodology for Intelligent Robotic Gripping

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Abstracts: As more companies adopt industry 4.0 protocols to improve their production lines, intelligent robots will continue to play an important role. Allowing robots to make decisions about tasks has the potential to drastically increase the efficiency of the production lines. Due to their adaptability, using soft robot grippers to perform pick and place operations will further improve the dexterity of a robotic system. This research will focus on creating an intelligent system capable of predicting the force required to grasp an object using computer vision and machine learning, then controlling the gripping force applied by a soft robotic gripper. This research will investigate methods to allow the system to learn from a continuous stream of objects as they are encountered by the robot. To overcome the inherent disadvantages of using soft robots, computer vision will be used as a sensor to capture the deformation of the gripper to generate force feedback for the control algorithms.

Research Interests:

- Control Theory
- Soft Robotics
- Computer vision
- Machine Learning

Review of Emerging Technologies in Electric Motor Propulsion Systems for Water Surface Vehicles

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Abstracts: Electric-powered surface vehicles have recently garnered significant interest from the academic and industrial communities. This fact is primarily due to the many benefits of electrical propulsion systems, including high efficiency and controllability. In this talk, we will cover the latest advances in motor-based propulsion systems - covering the complete system starting from the power source, then the power drive train's hardware and software design, and finally, the motor's mechanical design.

Research Interests:

- Electric motor design and control
- Robotics
- Power electronics

A Hybrid Signal Processing Framework for the Acoustic Noise Monitoring of Offshore Wind Turbines

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Abstracts: This research presents a novel hybrid signal processing framework to address the challenges posed by the non-stationary and complex noise environments characteristic of offshore wind turbines. The proposed framework integrates adaptive noise transformation, predictive filtering, and customized time-frequency decomposition techniques to enhance signal detection and reconstruction fidelity. A key novelty is the noise clustering and resampling mechanism that reshapes irregular noise distributions using a modified k-means algorithm with robust statistical methods to differentiate between environmental (e.g., wave and wind-induced) and mechanical noise (e.g., gearbox vibrations, blade resonances) while preserving critical features relevant for detection. The framework incorporates adaptive state- space models with dynamic feedback calibration employing an entropy-based cost function, which adjusts parameters in real time based on changing noise conditions. In addition, a custom- designed wavelet decomposition featuring frequency-adaptive Gaussian kernels is introduced to enhance transient noise discrimination beyond standard wavelet transforms. Extensive experimental validation with real world underwater acoustic signals including diverse noise profiles and varying signal-to-noise ratios demonstrates significant reductions in false alarms, enhanced detection sensitivity, and scalable computational performance.

Research Interests:

- Renewable Energy Sources
- Applications of Artificial Intelligence in Power Systems
- Smart Grid and Micro Grids
- Power Systems Operation and Control
- Energy Management and Optimization
- Power System Dynamics and Stability Analysis
- Artificial Intelligence based Predictive models
- Signal Processing

Mobile manipulation for object grasping and manipulation

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Abstracts: This presentation details the design and implementation of control algorithms for robotic grasping and manipulation using mobile manipulators. The focus is on developing robust strategies that integrate perception, planning, and execution to enable effective object interaction. We address challenges such as dynamic stability and kinematic redundancy, presenting experimental results that demonstrate the algorithms' efficacy in various grasping and manipulation tasks.

Research interests:

- Robotic
- System Control

Utilizing Autoencoder to Generate Realistic WGAN-based Adversarial Traffic

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Abstracts: Intrusion Detection Systems (IDSs) play a critical role in cybersecurity by identifying and mitigating network attacks. However, adversarial attacks can exploit vulnerabilities in IDSs based on machine learning (ML) techniques, causing misclassification of malicious traffic. Traditional adversarial approaches focus on IDS evasion but neglect the functional integrity of malicious traffic, limiting practical applicability. We propose a realism-preserving adversarial traffic generation scheme, AWGAN, which combines Wasserstein GAN (WGAN) with an autoencoder-based refinement process. The proposed scheme ensures that adversarial traffic retains its malicious characteristics while effectively evading IDS detection. In our research, we evaluate AWGAN using the CICIDS 2017 dataset and compare its performance against WGAN in two scenarios: modifying all features and modifying only non-functional features. Our experimental results demonstrate that AWGAN achieves an excellent balance between IDS evasion and traffic fidelity.

Research Interests:

- Realistic adversarial traffic generation using generative models
- Autoencoder-based stealth methods for IDS evasion
- Intrusion detection systems for the Internet of Things
- Adversarial attacks on intrusion detection systems

Masters Abstracts

An introduction to altitude-controlled tow-fish

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Abstracts: This presentation introduces the underwater constant altitude problem of towed vehicles. Solving this problem would allow for cheaper, safer, and more efficient ocean mapping. The presentation will cover the different aspects of the problem, sensors, cable configurations and dynamics, and control methods as well as an overview of previous work in the field.

Research Interests:

- Marine controls systems
- Ocean mapping
- Ocean renewable energy

Model predictive control of underwater tethered payload

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Abstracts: A buoy-based sensor system is being developed to acquire high-quality water column data and requires a controller to accurately position an array of sensors at various depths. The sensor system will be deployed to aquaculture sites, potentially in rough ocean conditions. Depth is measured by a pressure sensor and adjusted through a rotating drum powered by a stepper motor. The stepper motor's speed can be controlled by varying the pulse rate sent to the motor driver. The proposed controller uses a model predictive control (MPC) algorithm, a type of optimal control that predicts system response to optimize control actions. Simulations have been performed, and a practical test bench developed for testing the proposed controller in a limited test environment.

Research Interests:

- Advanced Control Systems
- Sensor Integration
- Industrial IOT
- Embedded Systems

Development of Analytical Redundancy Relations for Marine Engineering Systems for the Purpose of Fault Detection and Isolation

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Abstract: Marine engineering systems are inherently multidisciplinary, incorporating elements from a variety of engineering fields such as mechanical and electrical engineering. As a result, modelling of these systems is often inhibited by the artificial boundaries put in place by each discipline's respective modelling approach. This work aims to apply the bond graphing technique of system modelling, allowing the various domains within a marine engineering system to be combined into a unified model that concerns itself with the exchange of power and energy. By leveraging this approach, integration of fault detection and isolation (FDI) may then occur. More specifically, the use of analytical redundancy relations (ARRs) to allow for online detection of faults, and the potential isolation of fault cause. The methodology for deriving ARRs and their role in fault diagnosis is detailed. In doing so, a digital shadow of the marine engineering system may be created, forming the groundwork for preventative maintenance and opening the door for the realization of a fully developed digital twin.

Research Interest:

- Digital twinning.
- Predictive maintenance.
- Automatic controls.
- Modelling and simulation

Autonomous Pathfinding Through Sea Ice

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Abstract: Traversing ice-covered waters is a very challenging task, but doing so autonomously adds to the list of challenges. Depending on the concentration of ice floes, many of the most popular pathfinding methods would not find a solution. By accepting the inevitability of collisions with smaller pieces of ice, a relatively simple control-based pathfinding method can be used to navigate these concentrated ice floes.

Research Interests:

- Autonomous navigation
- Autonomous ocean systems
- Marine technology

Electromagnetic Modeling of a Biological Cell Using Terahertz Spectroscopy

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Abstract: Understanding how terahertz (THz) electromagnetic waves interact with biological cells opens new avenues for non-invasive diagnostics. This research focuses on modeling a biological cell—approximated as a prolate spheroid—to explore how THz radiation penetrates cellular structures and interacts with intracellular water. Due to the picosecond relaxation and vibration dynamics of water molecules, the THz frequency range is uniquely suited to probe these interactions.
Using CST Studio Suite, we simulate THz exposure scenarios and incorporate field-dependent membrane behaviour through VBA macros and MATLAB coupling. CST Circuit Co-Simulation is further employed to model membrane electroporation based on the Smoluchowski equation. Preliminary insights suggest that cancerous tissues, such as gliomas, absorb more THz energy than healthy tissue due to their higher water content and structural differences.
Our ongoing work aims to identify spectral fingerprints of cancer using THz spectroscopy and investigate how intracellular hydration patterns relate to cancer development. Ultimately, this model could enhance early cancer detection and enable frequency-tuned, targeted diagnostics.

Research Interests:

- Computational modeling using CST Studio Suite and MATLAB
- Bioelectromagnetics and electroporation mechanisms
- Frequency-selective targeting of intracellular components
- Simulation-driven approaches for cancer detection technologies

An Analysis of Coverage Path Planning Algorithms for Marine Environments

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Abstract: This presentation explores coverage path planning (CPP) for autonomous marine robotics, a crucial task for applications like seabed mapping and environmental monitoring. I will first define CPP and highlight key differences between online and offline approaches. The talk will then focus on applicable CPP algorithms in marine settings, including Morse-based boustrophedon decomposition and adaptive segmentation methods that address variable bathymetry.

Research Interests:

- Mobile Robotics
  - Path Planning
  - Cognition
  - Localization
  - Autonomy
  - Multi-agent Systems

Decoding the Unspoken: Enhancing Social Awareness in Robotic Systems Through Non-Verbal Human Cues

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Abstract: Over the past decades, the emergence of artificial intelligence and deep learning algorithms has accelerated advances in robotic perception, leading to frameworks for more sophisticated sensory processing and semantic understanding of the environment. However, the field of social mobile robot perception remains in its relative early stages of development. Despite significant strides in robotic perception, integrating social intelligence into robotic systems still poses substantial challenges. These challenges include accurately and robustly predicting human behaviors and emotions, effectively understanding social contexts, and inferring human intentions in different social settings.

To address these challenges, the present research attempts to develop a general framework to evaluate and infer human interaction willingness and intentions in social settings by integrating human non-verbal cues, such as eye gaze, head orientation, body posture, and facial emotions, with human relative localization and motion profile. This is achieved by designing a probabilistic, recursive metric to quantitatively estimate the willingness of a human to interact at a given time based on approachability and engagement levels, and then expanding this metric for multiple humans and through time to infer human-human, human-object, and human-robot interaction intentions based on nonverbal social cues.

Research Interests:

- Social Robotics
- Robotic Perception
- Human-Robot Interaction

Applying Doppler Sonar Techniques in Northern Newfoundland for Fish Tracking Near Mussel

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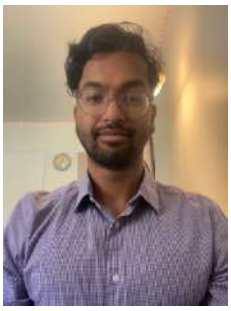
Abstract: In Newfoundland & Labrador, aquaculture is a very important industry, providing job stability for residents of the province, as fishing is one of the main occupations. A concern with aquaculture operations is how they might impact the local ocean ecosystem. We present one way to detect seasonal and spatial changes in ecosystem characteristics by using Acoustic Doppler Current Profilers (ADCP's). These instruments provide records of acoustic backscatter that can be used to continuously monitor the presence of fish and zooplankton in the water column. This project focuses on observations from Notre Dame Bay in Newfoundland from August 2021 to August 2022. One 300 kHz ADCP was placed in the bay near operating mussel farms, a second unit was placed at the mouth of the bay. From the data, no clear distinctions in observations are seen with proximity of the farms. However, we were able to clearly observe various detections of fish of different sizes. Throughout the year, it was found that there were typically between 50 - 200 detections per day, spanning over target strengths of -30 dB to -60 dB. Furthermore, from the volume backscatter data, the seasonal cycle of zooplankton can also be observed, with very little difference between the two instrument locations. We compare these acoustic observations with available field observations of water properties and plankton surveys.

Research Interests:

- Ocean Acoustics
- Fish Tracking using Doppler Sonar

AI-integrated Smart ICU IV system



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Abstract: This research proposes the development of a smart intravenous (IV) infusion system designed for intensive care unit (ICU) environments. The system will integrate real-time vital sign monitoring with an AI-powered control unit capable of adjusting medication delivery based on patient status. Using embedded systems and a touchscreen interface, clinicians will be able to monitor, regulate, and respond to patient needs more efficiently. The proposed system aims to reduce human error, improve clinical response time, and enhance overall patient safety by enabling semi-autonomous, closed-loop medication management. This work will contribute to the advancement of intelligent, patient-centered medical devices in critical care settings.

Research Interests:

- Wireless Vital Sign Monitoring Using RF Sensors
- Body-Worn Antennas for Medical Monitoring
- Wireless Power Transfer System for Medical Implants

Cooperative Object Manipulation with Multi-Robot System

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Abstract: This research explores strategies for multiple robots to collaboratively push a rigid object to a desired state. While cooperative transport remains challenging despite decades of study, it can solve problems beyond individual robot capabilities while improving flexibility, robustness, and stability. This seminar introduces the rationale behind this early-stage research and outlines objectives together with methodologies and simulation results.

Research Interests:

- Multi-Robot Systems
- Path and Motion Planning in Robotics
- Genetic and Behavior Control in Robotics

CircleRRT: Motion-Constrained RRT for Mobile Robot Navigation

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Abstract: This presentation introduces a balance strategy between path planning and motion control for holonomic robots based on the RRT algorithm. Traditional decoupled approaches often produce smooth but entangled paths with inconsistent computation times. Our method integrates motion constraints directly into the RRT by replacing discrete waypoints with pairs of tangent points derived from inscribed circles and generating analytic curves—straight segments and arcs—that respect a minimum turning radius. We propose two solutions: iterative path recalculation for higher accuracy and dynamic radius adjustment for faster performance. Extensive simulations across varied map demonstrate that this strategy achieves an optimal trade-off between path fidelity and computational efficiency. Future work will extend adaptability to dynamic environments and complex robot geometries.

Research Interests:

- Kinodynamic planning algorithms that jointly consider kinematic and dynamic constraints
- Safety-critical motion planning with formal guarantees
- Model predictive control (MPC) approaches for trajectory tracking with obstacle avoidance