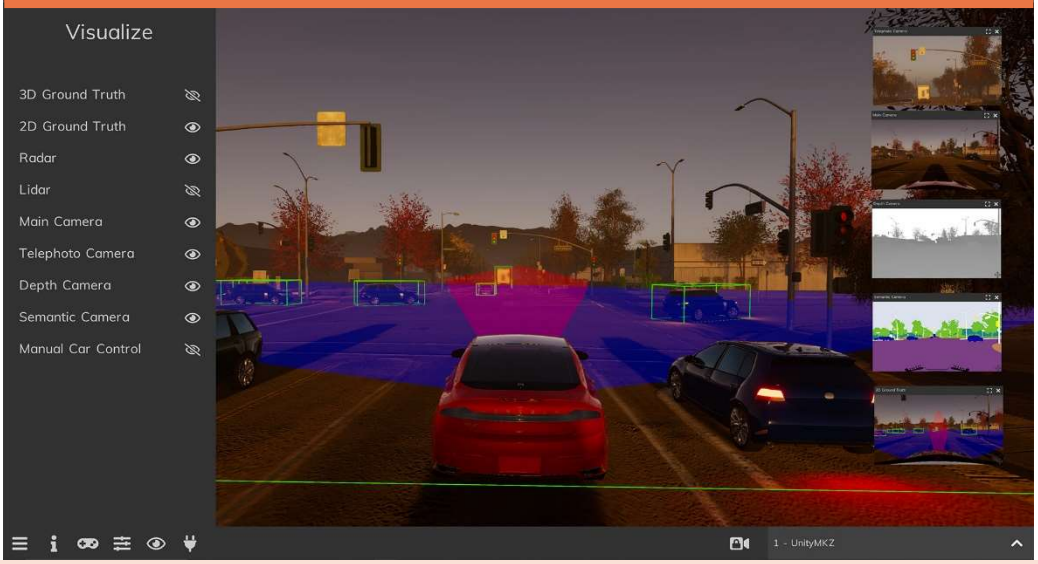
AUTONOMOUS SYSTEMS INITIATIVE

ASI Newsletter Volume 1 Issue 2 September 2020

Welcome to the second edition of the ASI Newsletter. September sees the start of the academic year, and many labs are resuming activity with carefully planned health measures in place. We look forward to bringing you the new and exciting work from the ASI teams this Fall! Our newsletter is available on our website or by email.

Research Highlight

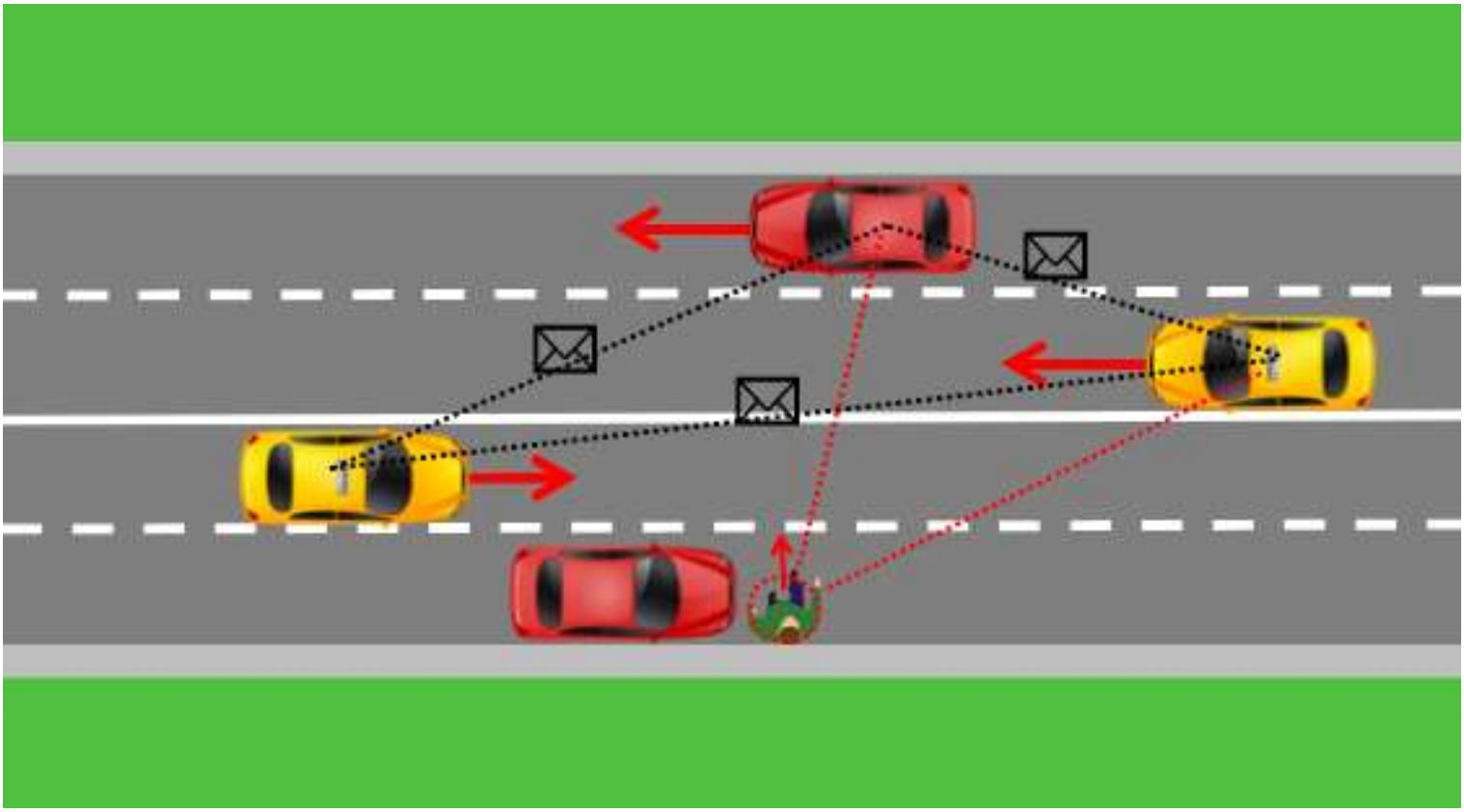


ASI NEWS IN BRIEF

- ASI Theme 2 Workshop: Real-World Automated Transport, October 2, 2020 (via Zoom) Register here
- We welcome all our new trainees this Fall!
- Currently $19M in pending grants

The dawn of automated vehicles is already upon us, but the work on the intelligent technology that underpins autonomous driving systems, designed to benefit pedestrians and drivers alike, continues. Our team from Theme 2 Mobile Communities is immersed in the cutting-edge research necessary to help these vehicles function safely and efficiently in our transportation ecosystem.

Autonomous driving is a key priority both nationally and for the province of Alberta, since it offers significant gains in efficiency and safety. This is all the more pressing given that the onset of COVID-19 has revealed vulnerabilities in our transportation systems, particularly for transit and supply chains. Connected and automated vehicles can provide across locations to maintain



economic activity. The potential benefits for communities across Alberta are significant.

Developing the artificial intelligence that allows automated vehicles to understand the world around them is key. Autonomous driving cars currently have a limited range of perception over the surrounding environment, much like humans. We are unable to see through objects or around corners, for instance. For connected vehicles, some of these perception limitations could be alleviated using an appropriate set of sensors and processing units. However, the perception range is limited to a few meters and, more importantly, the vehicles still cannot see past the frequent occlusions in populated roads and intersections.

> "Self-driving systems are going to be designed using a scalable approach and will fulfil lots of our navigation needs in more efficient ways"

Collaborative driving, the focus of the ASI research team led by Dr. Hong Zhang, Professor in Computing Science at the University of Alberta, would allow vehicles to share computational power and intelligently communicate the processed sensor information and data they gather with each other as they travel through their environments. Instead of sharing raw sensor data, which raises privacy concerns and increases communication delays, the goal is to share the processed sensor data with the nearby vehicles. Crucially, the amount of the shared data will decrease by orders of magnitude with the aid of machine learning (ML) methods. ML helps to efficiently extract and maintain the salient features, and to eliminate the unnecessary details, thereby augmenting the fleet's perception quality.

To be clear, the term perception here refers to the detection of the objects in the environment, including tracked dynamic objects and the prediction of their future trajectories. As such, the main goal of this research is to increase the perception quality of self-driving cars through vehicle-to-vehicle (V2V) communication, in contrast to unconnected vehicles as well as simple sharing of raw sensory data in current V2V approaches. This would allow the self-driving vehicles a rich and clear picture of the world around them, and improve their ability to make intelligent driving decisions.

Collaborative perception technology could not only improve the performance of connected vehicles but, more importantly, improve the safety of self-driving vehicles. For example, a tragic but sadly common accident is a pedestrian emerging into the road from behind a parked

vehicle since the view of the traveling vehicles is occluded. However, through V2V shared perception, vehicles can communicate their perceived state of the environment beyond visible obstacles, thereby avoiding potentially deadly accidents. Even in the shorter term, conventional cars with Advanced Driver Assistant Systems (ADAS) can provide their human drivers with warnings about the potential risks detected by collaborative perception. In addition, by using high-fidelity simulation testbeds to validate the developed AI algorithms, researchers can carry out the required experiments with little cost and no safety concerns.

The benefits of intelligent transportation research can go beyond the immediate application of improving the safety of self-driving vehicles. Ehsan Ahmadi, a Ph.D. student in the Department of Computing Science and a researcher on the team, sees automated driving as a part of the broader changes to the way we work and live. “The previous developments in industrial automation have greatly impacted our working lives by relieving us of the heavy lifting. The future of intelligent transportation will focus on having specialized AI-based systems that are not limited to engineered and structured environments. As related examples, mobile robots and self-driving systems are going to be designed using a scalable approach and will fulfil lots of our navigation needs in more efficient ways.

The project, on track for completion in 2023, brings together leading researchers in Alberta from across both computing science and transportation engineering, pushing the boundaries of what is possible. Ahmadi is optimistic. “I see the current phase of automation improvements as a great leap for the technology and our lives, which is going to be in the next level of an industrial revolution.”

The research team for the Collaborative Driving project is led by Dr. Hong Zhang, Professor of Computing Science, and includes Dr. Shaocheng Liu, Post-doctoral Fellow in Computing Science, Ehsan Ahmadi, Ph.D. student, and Siqi Yan, M.Sc. student.

Spotlight on HQP

This month we meet ASI researcher, Mohammad Parsazadeh from Theme 5 Industrial Communities

Working under the supervision of Dr. André McDonald, ASI Theme leader, and Dr. James Hogan, at the University of Alberta, Mohammad Parsazadeh is a postdoctoral fellow who joined the team after having completed his PhD in mechanical engineering at Memorial University, Newfoundland.

He is part of a project that centres on the autonomous robots that are being developed to perform remote manufacturing and repair processes for the Oil and Gas, renewable energy, and exploration industries. The application of materials, such as coatings, by these robots can be improved and optimized from currently available solutions. To improve these materials, simulations, informed by experiments, can be used to evaluate on microstructure features and mechanical properties that are most important for the performance of the materials in extreme environments (e.g., high temperature, wear). Mohammad’s work is to develop advanced modelling solutions that will result in a priori prediction of wear and erosion behaviour of select overlay and coating systems. The results of these material modelling solutions will be directly used to create parameters for semi-autonomous collaborative robotic fabrication of the repair solutions.

His contribution helps us understand these materials and how they react and function in different conditions, especially in the cold Alberta climate. The value, he says, is what it can bring to industry. “My project will help develop next-generation coatings to reduce surface degradation during Oil & Gas and Mining operations.” In addition, Mohammad’s results will make scientific contributions in nano-scale coating fabrication, experimental evaluation of damage evolution, physics-based modelling with validation, and materials design.

His project runs until 2021 and, after this, he hopes to take his valuable skills into Alberta industry. “Alberta has so many engineering opportunities, which is great for me,” he says enthusiastically. Plus, he enjoys skiing and hiking in his down time. What better place to be?

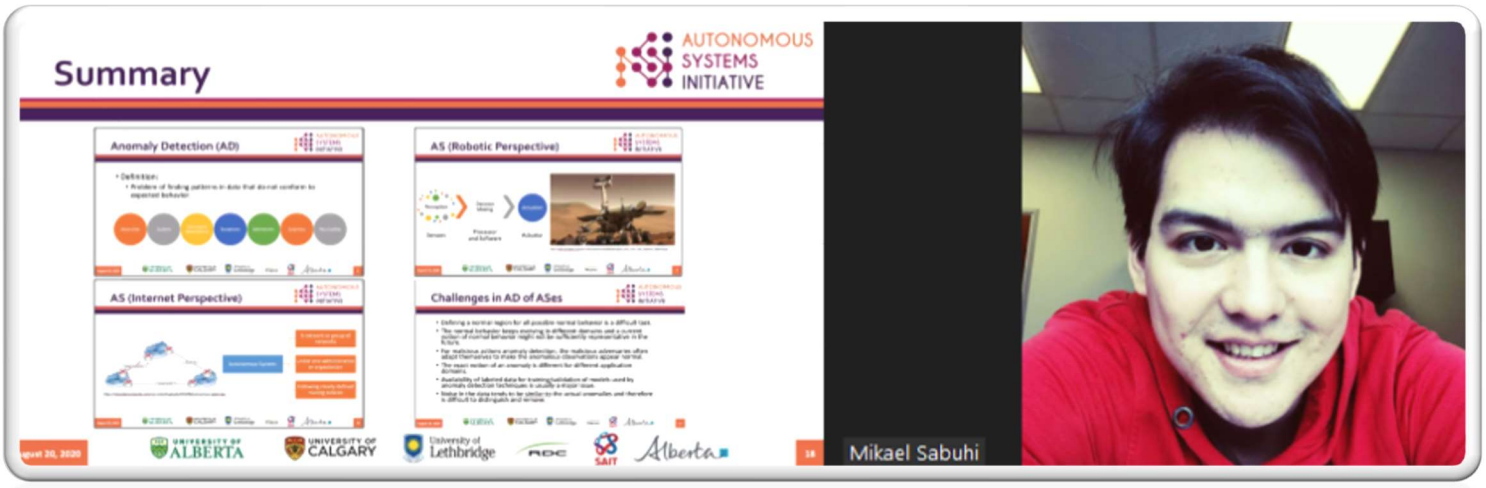
ASI Workshop Highlights

On August 20th, Theme 1 Methodologies and Tools for Autonomous Systems held the first in a series of Theme-specific workshops running over the Fall 2020 term. Chaired by the co-Principal Investigators, Dr. Henry Leung from the University of Calgary and Dr. Tongwen Chen from the University of Alberta, the event opened at 8:30am and comprised of twelve talks, broken down into three panels of four. Via an online platform, 51 attendees were able to hear from and engage with U of A and U of C researchers from across the team.

Each talk offered the opportunity for questions, with many talks such as “Event-Based Distributed Subgradient Algorithms” by Mani Hemanth Dhullipalla and “Autonomous Fault Diagnosis and Fault Tolerant Control” by Bahador Rashidi and Dr. Qing Zhao provoking lively and in-depth discussions amongst the participants. Attendees made particular mention of the highly informative and practically-focused keynote presentation “Optimizing Human-Autonomy Interaction” by Dr. Ming Hou from the DRDC.

If you missed the workshop but would like further information, you can still download the full program or contact us directly via email. Some presentations are available upon request.

We look forward to the next workshop, Real-World Automated Transport, to be held Friday October 2nd, 9am-4pm. The event is free, but all attendees must register through our Eventbrite page. Please see our website for more details



About ASI

The Autonomous Systems Initiative (ASI) is a forward-thinking, multi-million-dollar research program that teams up research and industry experts across Alberta to develop automated technologies spanning key areas of health, transportation, sustainability, and industry. Understanding and developing these systems will help us to remain economically competitive in a global context while effectively addressing the challenges of climate change, efficient energy production and use, transportation needs, advanced manufacturing, and medical advancement. This program develops new Information, Communications and Technology (ICT)-enabled Autonomous Systems to support healthy and sustainable communities with a focus on sensing, communication, control, and computation technologies, all linked together by artificial intelligence.

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