AUTONOMOUS SYSTEMS INITIATIVE

ASI Newsletter Volume 2 Issue 2 February 2021

Welcome to our February edition of the ASI newsletter. January was a busy month, with researchers immersed in their project work for Autonomous Systems and planning for the upcoming project year that begins in April 2021. We are looking forward to bringing you exciting updates as we progress!

Research Spotlight

Researchers in ASI's Theme 4 Healthy Communities are not just involved in technologies that support the delivery of healthcare to patients. They also are developing the training tools for our surgical staff here in Alberta.

Usually, surgical skill assessment and training is performed by surgical experts whose time is costly and limited. Currently few automated tools for objective surgical skill assessment and training are available in medical schools.

The ASI team's proposed autonomous surgical skill assessment and training tool can improve the training outcome and reduce its cost.

The research, entitled 'Objective Surgical Skill Assessment and Training', aims to develop autonomous technology to reduce the need for the presence of surgical experts and reduce the subjectivity of assessment and training. The team's proposed technology would measure the hand and arm motion, eye motion and muscle activities, to characterize surgical skill levels and provide

ASI News and Updates

Theme 4 Healthy Communities Principal Investigator Dr. Mahdi Tavakoli posts a call for papers (see p.4)

Theme 4 Workshop *Autonomous Systems for Surgery and Therapy for Healthier Communities* set for March 5.
Click here for more information.

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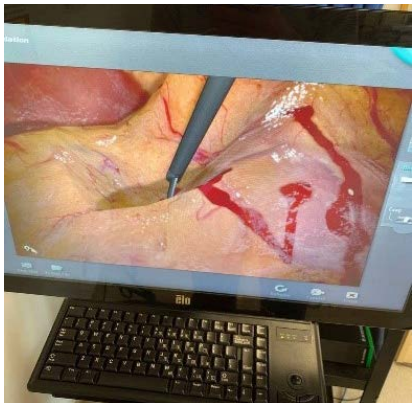
feedback for surgical training. The proposed autonomous technology would function based on embedded and wearable sensors and a virtual/augmented reality (VR/AR) environment for surgical skill assessment feedback-based training.

The team members are working in the Neuromuscular Control and Biomechanics Laboratory in the Department of Mechanical Engineering, the Surgical Simulation Research Laboratory in the Department of Surgery, and the Telerobotic and Biorobotic Systems Group in the Department of Electrical and Computer Engineering at the University of Alberta.

The team is developing an experimental setup and measurement technology to characterize the underlying differences between the performance of expert and novice surgeons using novel indexes that associate the surgical expertise and performance to hand motion metrics, eye-tracking metrics and muscle activity metrics. To this end, the team has been conducting experimental studies while following strict health and safety protocols due to COVID19 restrictions. Subsequently, to address differences between expert and novice surgeons and help novice surgeons enhance their skill, a VR/AR environment will be developed to hasten the achievement of the skills such as eye-hand coordination, depth perception and bimanual dexterity which are the vital elements of expert performance in minimally invasive surgeries.

Once developed, there are big wins for our healthcare system. Medical schools, surgery residents, patients, and the Canadian healthcare system will benefit through the savings to medical education costs and time as well as the significantly enhanced accuracy and reliability of surgical skill training.



The researchers are working with clear timelines to make this technology a tangible reality in the field. They have already established the idea conceptualization and experimental setup design. Over the next year they will focus on an experimental study toward data collection and characterization of surgical skill levels based on hand and eye motion. The research will then look at the development and implementation of a VR/AR environment for feedback-based surgical skill training to enhance neuromuscular control for surgical operations. In their final year, the project will develop and transfer autonomous technology based on embedded sensors and VR/AR environment for surgical skill training.

"This is certainly where Autonomous Systems technologies are headed," says Dr. Hossein Rouhani, who is leading the project. "We foresee that these technological tools and aids will be integrated into medical education, assisting educators and providing educational facility for medical students.

The team for Objective Surgical Skill Assessment and Training, based at the University of Alberta, includes Dr. Hossein Rouhani, Asst. Prof., Dept. of Mechanical Engineering; Dr. Bin Zheng, Assc. Prof., Dept.of Surgery; Dr. Mahdi Tavakoli, Prof., Dept.of Electrical & Computer Engineering; Farzad Aghazadeh, Ph.D. Mechanical Engineering.

HQP Profile

What comes to mind when we refer to the Highly Qualified Personal (HQP) that we train here in the ASI program are graduate students, Postdoctoral Fellows, and skilled technicians. But our teams also boast of some outstanding undergraduate students who are focused, motivated and passionate about this research. One such undergraduate engineering student is Edward Guo. Let's meet him!

The Summer of 2019 marked a significant moment for Edward Guo, a 4th year BSc student in the Department of Mechanical Engineering at the University of Alberta. That is when he was introduced to research, under the supervision of Dr. Bob Koch. He grabbed the opportunity to be involved in the Homogenous-Charge Compression Ignition (HCCI) engine setup, a low temperature high efficiency combustion mode with low emissions. Shortly thereafter, he was able to work with Continental in their powertrain division on evaporative emissions parts.

Since then, his list of research activities has grown impressively. Continuing under Dr. Koch, Edward has worked on tasks such as a citywide emissions inventory of mobile and stationary sources, in-vehicle diesel emissions testing, dual fuel hydrogen diesel engine, and setup for a Biojet project. He is also a 2-time NSERC Undergraduate Student Research Award (USRA) holder.

The areas that most interest Edward are powertrain and emissions regulation, which fits squarely within the ASI project 'Autonomous Road Vehicles Systems for Improving the

Emissions Footprint of Urban Passenger Transportation' led by Dr. Koch and ASI Scientific Director Dr. Tony Qiu.

Certainly, urban passenger transportation technologies have improved considerably in recent years. Vehicle emissions and environmental footprint are carefully regulated at the time of production. However, real-world driving of vehicles under various operating and maintenance conditions can generate higher emission rates, which goes against the aims of the new vehicle designs.

Some causes for higher emission rates have been identified and include tampering with a vehicle's exhaust, regular mode switching of hybrid-electric vehicles causing cold exhaust, aggressive driving behaviour, and the extreme cold climate of Canadian cities.

Edward's focus is on understanding urban vehicle emission behaviour in real-world operating conditions. The idea is to use collected data to develop algorithms and technologies for emission reduction using an autonomous vehicle, connected vehicles, and artificial intelligence tools.

His testing method involves an activity he loves- driving. "I have instrumented a vehicle with emission measurement sensors and driven the vehicle in a series of controlled driving cycles in Edmonton. Real-world emission rate data is collected and analyzed to understand the role of operating conditions and ambient temperature on exhaust toxic emissions. The goal is to continue tests through the Edmonton winter to obtain cold weather emission factors, currently something that is often unknown."

He goes on to say that "Real-world driving emission factors at various operating conditions will help ASI research to develop driving cycles and sensing technologies that reduce emissions and energy consumption. Using AS, connected vehicles, and artificial intelligence algorithms are technological opportunities to minimize urban transportation's environmental impact."

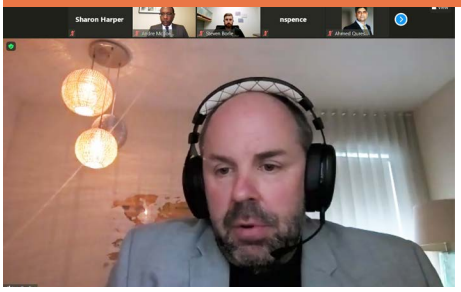
His passion for all things automotive spills over into his free time as well. He has been the Suspension Lead for the University's Formula SAE team, a student design competition run by SAE International (formerly Society of Automotive Engineers) to design a small Formula-style race car. This has allowed him to broaden his knowledge on a race car's vehicle dynamics as well as its design and manufacture.

So what next for this engineering dynamo?

"I would like to enter either the automotive or aerospace industries in areas like powertrain or aero and vehicle dynamics. Or possibly I'll do a Master's first."

One thing is for sure, Edward will be one to watch for the future.

Workshop Highlight



At 9am on Tuesday February 2nd, 148 registrants were set for Theme 5 (Industry Communities)'s workshop *Robotization of Industrial Repair and Manufacturing for Alberta: Promises and Pitfalls*. Opened by keynote speaker Luc Pulliot (pictured above), co-owner of PolyControls Technologies, the workshop was led and delivered by a collaborative multi-faceted team of stakeholders from university, college, industry, and government.

The team passionately feels this type of engagement and discussion is crucial for autonomous systems and industry. As Prof. Martin Jägersand, a researcher on the project whose presentation linked innovative research in robotics and automation with Alberta industries, explains,

"Alberta's main economic sectors, natural resources and construction, will need more flexible approaches to robotics and automation compared to manufacturing, where the majority of the 2M robot arms today are in use. In field applications, robots need to adapt to varying task geometries, and rely more on sensing and model estimation (learning). Unlike manufacturing in a particular sector, say cars, automated tasks outside factory production pose different problems, and both hardware and software need to be targeted to the application by engineers educated in robotics and mechatronics."

The lively debates throughout the day indicated that these issues are pressing across the sector. A highlight was the industry round table, where there was an honest discussion of barriers and solutions to the adoption of autonomous technology in Alberta, with many feeling that the session paved the way for a concrete understanding of robotics-derived manufacturing and repair.

Theme Leader, Prof. André MacDonald summed up many participants' leaving impression. "This workshop was a perfect opportunity to build awareness about work that is taking place on integration of autonomous systems in manufacturing and repair of equipment in Alberta."

Pictured below: Presentations on testing and laboratory capabilities at both the University of Alberta (left) and Red Deer College (right), partners in the Autonomous Systems Initiative

The 1st IEEE International Conference on Autonomous Systems

IEEE ICAS 2021

INTERNATIONAL CONFERENCE ON AUTONOMOUS SYSTEMS
Montréal, Canada | August 11-13, 2021

IEEE | IEEE Signal Processing Society | ASI

CALL FOR PAPERS

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TOPIC AREAS

The 1st IEEE International Conference on Autonomous Systems (ICAS 2021) will take place in Montréal, Québec, Canada on August 11-13, 2021. The IEEE ICAS 2021 will be a premier international forum for presenting the technological advances and research results in the fields of theoretical, experimental, and applied Autonomous Systems (AS). Original papers are invited from multidisciplinary, interdisciplinary and transdisciplinary perspectives on subject topics in Autonomous Systems including, but not limited to, the following:

THEORETICAL FOUNDATIONS OF AS
- Intelligent Foundations of AS
- System Foundations of AS
- Mathematical Foundations of AS
- Computational Foundations of AS
- Brain Science Foundations of AS
- Cognitive Foundation of AS
- Bottlenecks of Adaptive Systems
- Indeterministic & Uncertainty Behaviors of AS
- Interaction Between Humans and AS
- Autonomous Computing Platforms
- Neurological Foundations of AS
- Signal Processing Theories of AS

EMERGING FIELDS OF AS
- Autonomous Computers
- Autonomous Algorithms
- Brain-inspired AS
- Machine Learning
- Autonomous IoTs
- Self-driving Vehicles and Vessels
- Autonomous Robots
- Real-time AS
- Autonomous Unmanned Systems
- Trustworthiness of AS
- Mission Critical Systems
- Autonomous Perception/ Computer Vision

AS ENGINEERING
- Applied Paradigms of AS
- Autonomous Programming
- Cognitive Inference Engines
- Autonomous Robots
- Distributed AS
- Embedded AS
- Communications among AS
- Communications Between AS and Humans
- Autonomous Operating Systems
- Autonomous Sensors
- Autonomous Swarms
- Social AS

The following special tracks will also accept papers from the main submissions:

Autonomous Medical Robotic Systems, Co-Chairs: Dario Farina (UK), Mahdi Tavakoli (Canada) and S. Farokh Atashzarm (US)

Security and Resilience of Autonomous Cyber-Physical Systems, Co-Chairs: Deepa Kundur (Canada) and Mohammad Al Janaideh (Canada)

Autonomous Control Systems, Co-Chairs: Dr. Giuseppe Franze (Italy) and Walter Lucia (Canada)

Autonomous Transportation Systems, Co-Chairs: Chun Wang (UK) and Anjali Awasthl (Canada)

Signal Processing for Self Aware and Social Autonomous Systems, Co-Chairs: Usman Khan (USA) and Hoi-To Wai (Hong Kong)

IMPORTANT DATES

February 3, 2021 Special Session Proposals Due	**March 3, 2021** Paper Submission Deadline	**May 21, 2021** Notification Due	**June 1, 2021** Final Version Due

2021.ieee-icas.org

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