AUTONOMOUS SYSTEMS INITIATIVE

ASI Newsletter Volume 1 Issue 5 December 2020

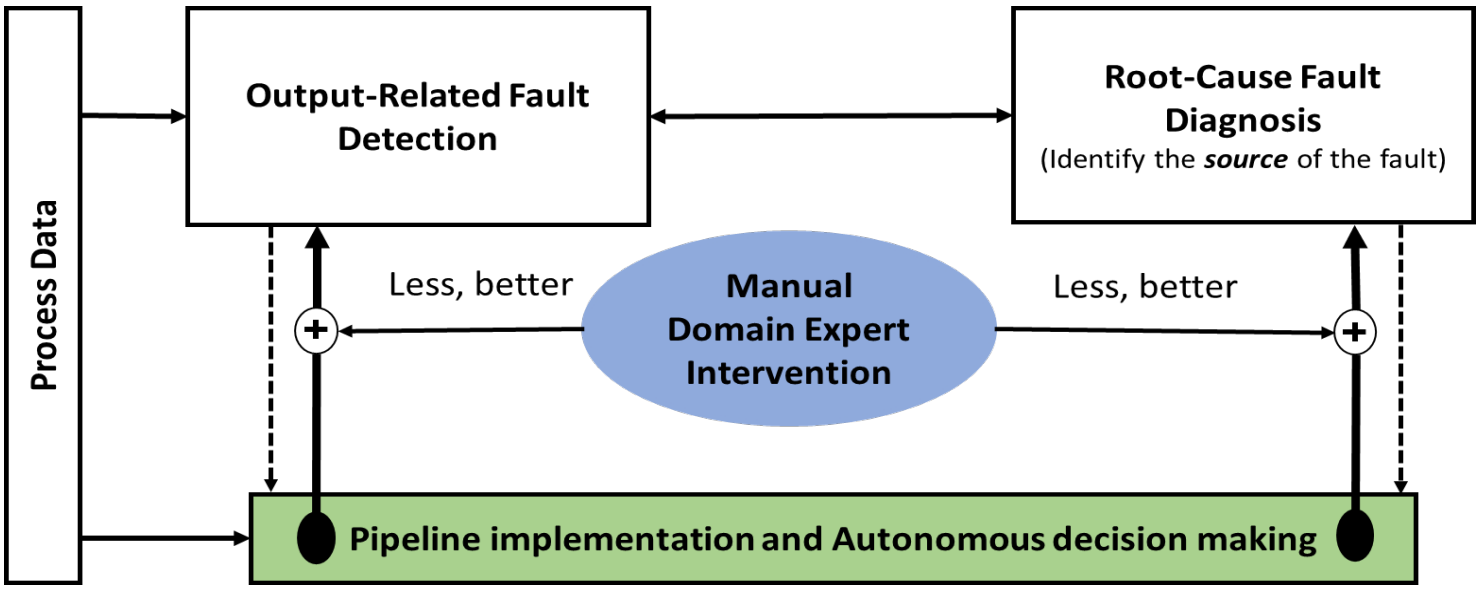
We have reached December here at ASI, and we are pleased to have made fantastic research progress during otherwise challenging conditions. For many of us remote working at learning has become the norm in 2020, but we have continued to connect, create and discover. We hope everyone has a well-deserved winter break, and we look forward bringing you more exciting work we are doing in the new year.

ASI NEWS IN BRIEF

- ASI Strategic Advisory Board meeting on December 3rd
- Workshop for Theme 5 is now ready for registration! (see p. 4)

Research Highlight

Our research story for December comes from Theme 1 Methodologies and Tools for Autonomous Systems. Led by Dr. Qing Zhao in the Department of Electrical and Computer Engineering at the University of Alberta, this project seeks to develop autonomous monitoring systems for industrial systems.



Schematic diagram of the suggested autonomous system monitoring platform consists of fault detection and root cause fault diagnosis with special attention on minimizing manual intervention and/or real-time domain expertise

One of the timely demands made by process operators is to have an autonomous platform that provides accurate monitoring indices for the system, with fewer requirements for domain knowledge, engineering intervention and parameter tuning. This research proposes a scheme of advanced quality-related fault detection for non-stationary/non-linear processes to automatically monitor the impact of the faults on key performance indicators (KPIs).

Quality-related fault detection (FD) is an active line of investigation in the industry, where the application of deep learning approaches is relatively new. The research project from ASI's Theme 1 proposes a deep learning-based solution that follows a new way of output-related FD. In their work, the FD bypasses the stationarity limiting assumption of existing methods and can be applied to a wider range of systems.

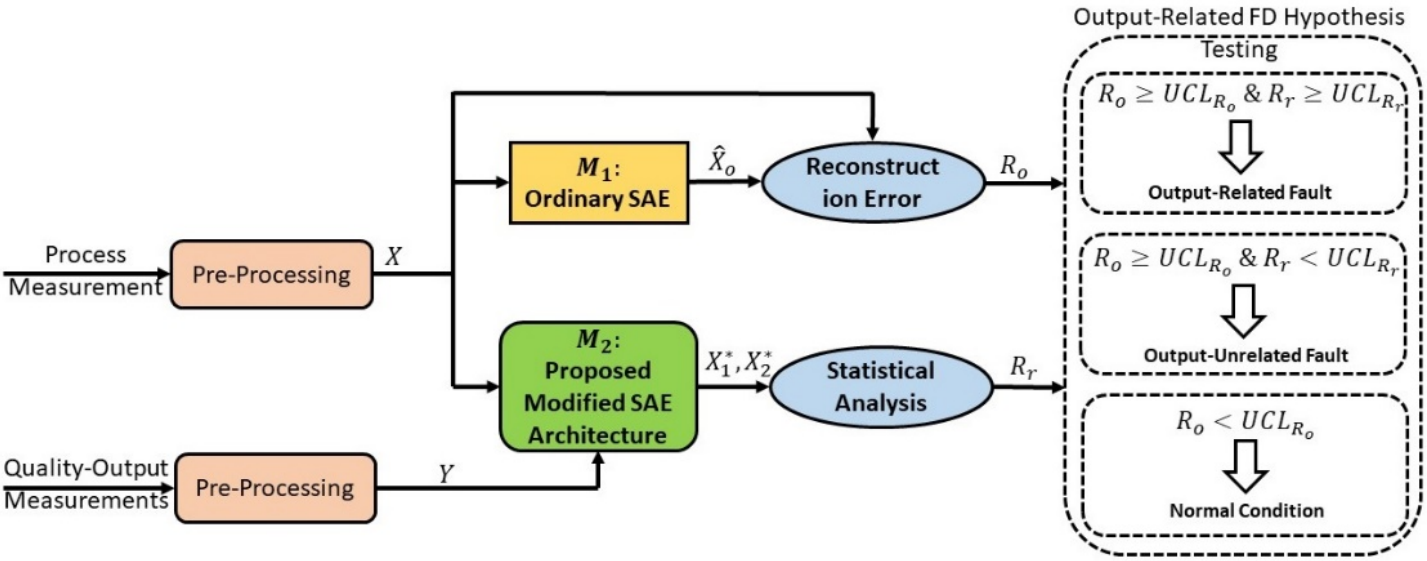
Dr. Bahador Rashidi, a Postdoctoral Fellow working under Dr. Zhao at the U of A, says that the ideal achievement for this project would be to deploy this approach into an autonomous pipeline with little or no tuning and domain expertise. The beneficiaries, he explains, will span across those industries with heavy maintenance costs or personnel exposed to unsafe working environments by taking advantage of this autonomous solution. This platform increases the level of reliability and safety by making the monitoring system independent from the real-time intervention of engineers, reduces the risk of human error and takes advantage of large quantities of historical data for proactive maintenance.

But then industry formed the foundations of this project. It began as a collaboration with industrial partner Honeywell Process Solutions, followed by NSERC Engage and Engage+ financial support. Honeywell provided industrial datasets with defined problem statements, which allowed the team to investigate the implications of the proposed deep learning-based solutions. Now, the work has been approved by NSERC for a CRD grant. "We are enthusiastic to expand our research to perform research on reinforcement learning-based approaches within our general idea of autonomous system monitoring.

Dr. Rashidi adds, "There is no doubt that industry is being transformed by technology. Thanks to high speed internet technology and fast development of big data supported by AI, autonomous system operations are more tractable in many engineering applications, making ASI's work incredibly relevant."

This work, which began in September 2019, is currently in development and aims for completion in September 2023.

Dr. Qing Zhao is a Professor and Dr. Bahador Rashidi is a Postdoctoral Fellow, both in the Dept of Electrical and Computer Engineering at the University of Alberta. They will be joined by a Ph.D. candidate and an M.Sc. student in the near future.



Schematic diagram of the proposed quality-related fault detection strategy using modified SAE architecture, in which M_1 is responsible to detect the presence of the fault in the measurements and M_2's role is to generate a monitoring index (R_r) to measure the impact of the detected fault on quality output variables

Spotlight on HQP

Turning our attention this month to Theme 2 Mobile Communities, we are pleased to introduce Andrés Rosales-Castellanos, a PhD student in the Department of Civil and Environmental Engineering at the University of Alberta.

ASI boasts a network of collaborations aimed at best addressing leading issues in automated technology. One way that we achieve this is by providing our HQPs combined supervision from across areas of specialization.

Andrés is one such HQP who has input from across faculties. Currently under the supervision of both Dr. Tony Qiu from the Faculty of Engineering and Dr. Michael Buro from the Faculty of Science, Andrés is able to fuse Transportation Engineering with Computer Science expertise.

That interdisciplinarity is important for both current and future transportation needs, not least to tackle growing traffic congestion problems in cities around the world that affect our health and mobility.

"To address this," he says, "we need to help vehicles move fluidly as they travel. Traffic signal optimization is an ongoing challenge, and this will increase as autonomous vehicles join our roads. My research focuses on determining the best behavior for autonomous vehicles to increase mobility in conjunction with an optimal design for traffic signals at intersections. This problem needs both transportation and computer systems knowhow.

My hope is that the research leads to safer roads, more available time, less fuel consumption and less stress from commute dynamics."

With a BSc in Electronics Engineering from Universidad Nacional Experimental del Táchira (UNET) in San Cristóbal, Venezuela and an M.Sc. in Electrical Engineering from Universidad de Guanajuato (UG) in Guanajuato, Mexico, Andrés has always been aware of the global nature of these issues. In fact, it was the award of a full scholarship from the Mexican Council for Science and Technology (CONACYT) that sparked his curiosity for research and development.

Undertaking real-world testing at U of A's South Campus, where Phase 2 of ACTIVE, Canada's first Connected Vehicle testbed, is located

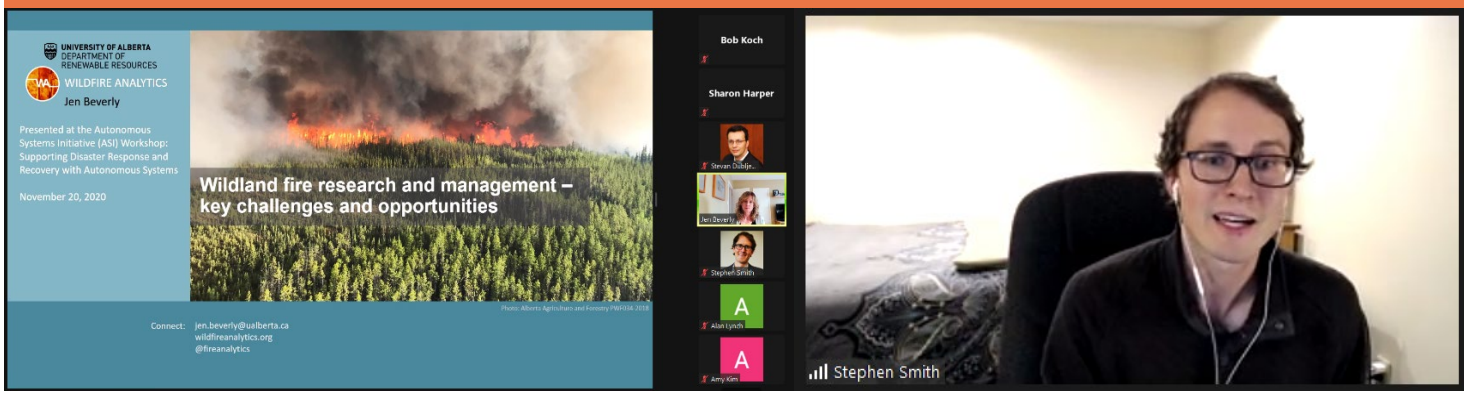
He also has a sense of how these applications cross many areas of our lives. Although he is focused on transportation now, he has also worked with medical applications and smart homes in the past.

> These problems need both transportation and computer systems knowhow

But he sees the human relationship with technology as crucial. "Although I think autonomous systems will be at the forefront of industry manufacturing and repair, I believe human intervention will be needed, especially in terms of creativity. Neural networks will work instead to greatly improve industrial processes in terms of time, cost and precision."

Andrés expects to finish his PhD in the first quarter of 2023 and would like to help develop policies for implementation of these technologies and making our roads and means of transportation more efficient.

ASI Workshop Highlights



Theme 3 Sustainable Communities gathered virtually on Friday November 20th to discuss the potential of autonomous systems in key support in areas such as monitoring, identification of emergency supply locations and evacuation coverage. The afternoon included a range of speakers from across the field including Stephen Smith (above right) from the University of Waterloo and Jen Beverly from the Dept of Renewable Resources at the University of Alberta (above left). Dr. Amy Kim, a Principal Investigator for Theme 3, noted that the highlight of the workshop was the range of talks. "We had research in ASI, research on autonomous systems from another leading lab in Waterloo, and application areas for autonomous systems. There was something for everyone."

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.

SAVE THE DATE: February 2nd 2020, 9:00am – 2:45pm

The University of Alberta, Red Deer College, and InnoTech Alberta, in collaboration with the Autonomous Systems Initiative, are proud to present a Workshop on **Robotization of Industrial Repair and Manufacturing for Alberta: Promises and Pitfalls**. This one-day event brings together industry, academia, and government to participate in interactive online engagement around cutting-edge materials, manufacturing, and repair strategies that feature integration of semi-autonomous robotic systems.

The event is an excellent opportunity to learn about recent research and technology development through presentations, videos, online tours, and a live industry round table discussion. The Workshop will explore applications for manufacturing and autonomous repair in the Alberta resource sector.

This event is free but requires participants to register via Eventbrite. Please click here to go to our event page.

You can find a copy of the workshop agenda on our website.

This ASI workshop is hosted in conjunction with InnoTech Alberta.

Contact Us

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