AUTONOMOUS SYSTEMS INITIATIVE

ASI Newsletter Volume 2 Issue 4 April 2021

With Spring 2021 comes renewed optimism for our ASI research community. We've had many exciting developments over the Winter term, including the introduction of several new academic and industry members on our Scientific Committee, the drafting of our vision and mission statements, the approval of our projects moving into their 4th year of development, and a welcome increase in HQP recruitment. Things to look out for over the next few months are the revamping of our website and newsletter format, and our annual workshop set for June 2nd. More details will follow.

In conjunction with the recent Telus/University of Alberta research partnership announcement (see box right), U of A's in house magazine, The Quad, recently featured an interview with ASI's Scientific Director, Dr. Tony Qiu, looking at his role as an innovative researcher in Automated Transportation. You can read the full interview by clicking here.

BREAKING NEWS!

You may have heard the exciting news about the **$15 million partnership between the University of Alberta and Telus** to develop a **5G Living Lab** announced recently. Our Scientific Director, Dr. Tony Qiu, played an important role in its development, ensuring that research into autonomous systems is one of two key areas at the forefront of this initiative. We look forward to working closely with Telus under the umbrella of the 5G Living Lab to further expand research on automation and will bring you updates on developments as they arise.

For full details and to see the original announcement, click here.

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Research Spotlight

The study of fundamental systems that supports our understanding of autonomous systems is crucial to the ASI's research program. Without it, applications are bound to encounter difficulties or serious limitations, making the work of Theme 1 Methodologies and Tools for Autonomous Systems a key component of our research ecosystem.

An important project within this theme investigates Intelligent Technology Stack for Autonomous Systems. Led by Principal Investigator Henry Leung from the Schulich School of Engineering at the University of Calgary and the University of Alberta's Petr Musilek and Marek Reformat, the study investigates a stack of intelligent techniques based on artificial neural networks and conventional artificial intelligence to extract useful information from data. The significance of this work sits particularly with its aim to combine this collection of intelligent techniques into an integrated intelligent system that can be applied to different industry sectors and across a range of uses, including infrastructure anomaly detection, 3-dimensional sensing, common sense perception of environment, and establishing trust through blockchain.

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This has huge potential for industry, as they would be able to generate massive amounts of data in their processes, automate their systems and enhance their performance. In particular, oil and gas industry will be able to use the developed algorithms for predicting equipment failures, as well as modeling of reservoirs and drill sites. In addition, the techniques have potential for public transportation in automated mobile systems for sensing and analyzing their environments.

Understandably, the project has already attracted significant industry interest. Dr. Leung explains, "We have already established industrial collaborations in different industrial sectors such as power and energy, defense and security, oil and gas, infrastructure, and information technology." Collaborative projects with these industries are already under development, including with companies and government bodies as diverse as Hifi Engineering, L3Harris, Baker Hughes, Leica Geosystems, City of Calgary, Thales Canada, ReWatt, EQUS, Honeywell Canada, ATCO, and AltaML.

Bringing together the rich combination of fundamental study of systems and industry input suggests that the impact of this project will be multi-layered. The research is novel and will provide fundamental contribution to the machine learning research community. The research is expected to generate many high-quality publications on novel machine learning algorithms with application to autonomous systems. The work on applications based on machine learning will also advance the research knowledge in various fields including block chain, power systems, pipeline engineering, sensor surveillance, signal and image processing.

The team also aims to commercialize some of these innovations through technology transfer, licensing and patenting. The work will integrate some of these algorithms to develop an intelligent system for anomaly detection to Technology Readiness Level (TRL)5 with applications to different industrial sectors. Dr. Leung is confident that the work will have a a significant impact. "Our research-industry collaborations, our trained HQP, and the commercialization of our research results will contribute directly to Canadian industries."

The time frame for this work is just over 2 years. Starting in 2021, the team will develop fundamental machine learning algorithms. In the second year, the emphasis will be on the application of these algorithms to different industrial problems, system integration development and technology commercialization.

Ultimately, autonomous systems have expanded from conventional robotics to autonomous cars, health care systems and manufacturing with the required autonomous systems hardware. In addition, with the increasing amount of data in many sectors, autonomous or semi-autonomous processes will be in high demand to enhance the operational efficiency in these various industries. That makes the work from Intelligent Technology Stack for Autonomous Systems not just interesting but crucial to our economic, social and industrial way forward.

The team for Itelligent Technology Stack for Autonomous Systems includes Dr. Henry Leung, Prof., Dept. of Electrical and Software Engineering at the University of Calgary; Dr. Marek Reformat, Prof., Dept. of Electrical and Computer Engineering at the University of Alberta; and Dr. Petr Musilek, Prof., Dept. of Electrical and Computer Engineering at the University of Alberta.

HQP Profile

This month we bring you a spotlight on not one but two ASI HQP, working together under Dr. Rafiq Ahmad on Theme 5 Autonomous Systems for Industrial Communities. Habiba Imam and Hamdan Al-Musaibeli form a core team looking at autonomous repair.

With growing public concern about climate change, manufacturing waste has come under scrutiny. The manufacturing sector produces around 60% of non-hazardous waste, and in order to move towards a sustainable economy, it is crucial to manage this.

Research currently being undertaken by this month's featured HQP, Habiba Imam and Hamdan Al-Musaibeli, looks at a method for damage detection, localization, and tool-path planning for cylindrical components, one strategic piece of the solution to the problem of manufacturing waste.

Cylindrical geometry is amongst the most commonly produced primitive geometry in manufacturing. A repair process restores value in a damaged component by bringing it back to like-new condition, allowing for reuse rather than disposal. Understandably, this offers numerous environmental and economic advantages.

However, the most important information for repairing a worn component is determining the scale of damage, and the current repair process relies heavily on human operators for damage detection and localization. This work is both dangerous and costly.

To address the safety implications as well as repair process, the team at the Laboratory of Intelligent Manufacturing, Design, and Automation (LIMDA), led by Dr. Rafiq Ahmad, propose a novel repair framework for cylindrical components by incorporating deep learning and computer vision technologies. A vision-based system is designed first to detect the damaged region in pixels, then, using that information, automatically localize the damage in spatial (3D) coordinates. A 3-dimensional point cloud data of the localized region is acquired using a time-of-flight sensor, and based on the geometry of the damage volume, an adequate tool-path is generated for depositing material by laser cladding technology.

Both Habiba and Hamdan are excited about the potential for this technology. "We believe that autonomous systems will gradually transform the manufacturing and repair industry. These systems will play a crucial role in increasing quality, productivity, and safety while eliminating waste. With that being said, ample human intervention will be required to keep the autonomous systems working for their intended purposes," says Habiba.

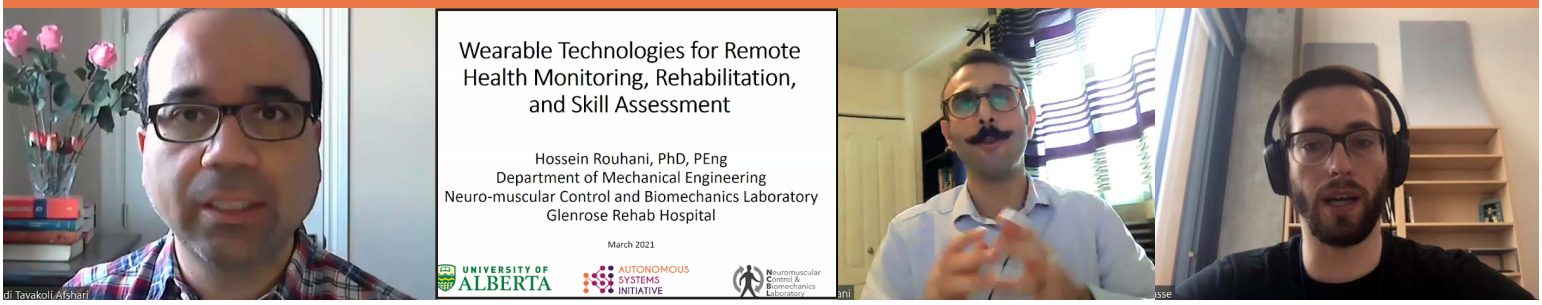
And these two bright young talents bring rich international experience and perspective to the team. Habiba gained a B.Sc. in Mechanical Engineering from Eastern Mediterranean University, Cyprus, in 2017 while Hamdan graduated with the same degree from Taibah University, Medina, in 2019. Both are currently pursuing their M.Sc. in Mechanical Engineering at the University of Alberta while working at LIMDA.

Both came to Alberta as international students, convinced by its reputation for Engineering research and welcoming environment. Habiba reflects upon the impact of experiencing different cultures. "I have realized that my identity is an integration of the aspects of each culture that resonated with me. As well, meeting people from different parts of the world has helped shape who I am today." And attracting these bright minds from across the world is an important part in Alberta's future success.

Both hope to stay in Alberta once they have completed their studies. Hamdan has plans to continue on to a Ph.D. at the University of Alberta once finished his M.Sc. Habiba says she is still considering the different directions she might take her career, and says she is interested in the role or influence of engineers in public policy making. "I feel it is important that engineers participate fully in these important decision processes and would like to someday be involved."

But Alberta also has something else holding her here. "I haven't had enough of the beautiful Rockies just yet."

Latest Workshop news



A dedicated audience gathered for Theme 4 Healthy Communities' recent Autonomous Systems for Surgery and Therapy for Healthier Communities workshop, which took place virtually on March 5th. With close to 150 registrants, ASI Researcher Dr. Garnette Sutherland, Professor of Neurosurgery at the University of Calgary opened the day's events with an insightful look at 'Sensors, AI and Digital Innovation in Surgical Robotics'. Speakers were from across Campus Alberta, including University of Calgary, University of Alberta and the the University of Lethbridge, as well as industry speaker Lukas Grasse from Reberb Robotics.

Dr. Madhi Tavakoli, co-PI for Theme 4, and has confirmed that two new potential collaborators came forward afterwards and feels it was testament to the excellent team. "It really is thanks to what everyone contributed and also the diversity of the expertise and perspective we have in this theme. We have surgeons, dual MD/PhD degree holders, engineers, and scientists and so their discussion is highly interesting when they get together."

If you missed the workshop but would like further information on the speakers or talks, you can still download the full program or view the presentations.

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, linked together by artificial intelligence.

Contact Us

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