UNIVERSITY OF ALBERTA
FACULTY OF REHABILITATION MEDICINE

REHABILITATION ROBOTICS

A LOOK INTO THE FUTURE OF REHABILITATION TECHNOLOGY

2019-2020

UNIVERSITY OF ALBERTA
FACULTY OF REHABILITATION MEDICINE

Rehabilitation Robotics Lab

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WE HAVE VISION

The Rehabilitation Robotics Lab (RRL) enriches, empowers and enhances society by designing personalized, universally accessible communities.

Our lab is part of the University of Alberta's Faculty of Rehabilitation Medicine. We are led by two primary investigators: Martin Ferguson-Pell and Greg Kawchuk. The research teams boast a community of researchers, undergraduate and graduate students and postdoctoral fellows from multiple faculties, including the Faculties of Medicine & Dentistry, Science and Engineering. We also hold membership in the SMART Network, an interdisciplinary research group at the University of Alberta.

Through collaboration, we continue to be creative innovators in rehabilitation for the future.

OUR PROJECTS

Biomechanics and Disability

Biomechanics and Low Back Pain

Cognitive Projections

Parallel Robotics

ProjectDR

Tele-Rehabilitation 2.0

OUR STARTUPS

Click&Push Accessibility Inc.

VibeDX

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OUR COLLABORATORS, SPONSORS AND DONORS (THANK YOU!)

ATB

Alberta Bone & Joint Health Institute

Alberta Innovates / Pfizer Inc.

Alberta Spine Foundation

CFI

EON Reality

Health City

Kinetisense

Motion Composites

Prospect HR (Calgary)

SMART Network

ST Innovations

University of Alberta

We would also like to acknowledge and thank all of our colleagues across the University of Alberta for their contributions to our work.

TELE-REHAB 2.0: INCREASING ACCESS TO REHABILITATION SERVICES IN REMOTE COMMUNITIES

In Alberta, over 700,000 residents live in rural and remote locations, but rehabilitation specialists are found mainly in Edmonton and Calgary. This means that a large percentage of Albertans have to travel, often for 10-hours or longer, just to access quality rehabilitation services that are already readily available to those who live in urban centres. The issue of health care inequality based on location is something that the University of Alberta's Rehabilitation Robotics Lab is trying to solve.

Through the Tele-Rehabilitation 2.0 project, video conferencing supported by a range of new sensor technology will allow a rehabilitation specialist to communicate with patients in rural and remote communities at their local clinics. This means that patients will get access to expert care without having to go any further than they already would for a general medical appointment.

This pilot project is looking to prove that the concept of health care using remote teleconferencing is possible. Tele-Rehab 2.0 will be starting with four groups of assessments: wheelchair and special seating, shoulder pain, vertigo and balance issues and post-hip and -knee surgery follow-up appointments.

Tele-Rehab 2.0 optimizes existing technology, like advanced video conferencing and sensors (such as those used for measuring the force behind a push), and also works with existing companies, such as Kinetisense from Medicine Hat, Alberta, to create new software applications that use markerless motion capture technology.

To learn more about this exciting project, visit uab.ca/rrl.

CORE PROJECT TEAM: Emily Armstrong, Courtenay Badran, Martin Ferguson-Pell, Sydney Hampshire, Emmanuella Osuji, Kaitlyn Sosnowski, Andrew Vonow

WHAT WE'RE WORKING ON

A LOOK INTO THE FUTURE OF HEALTH-CARE TECHNOLOGY

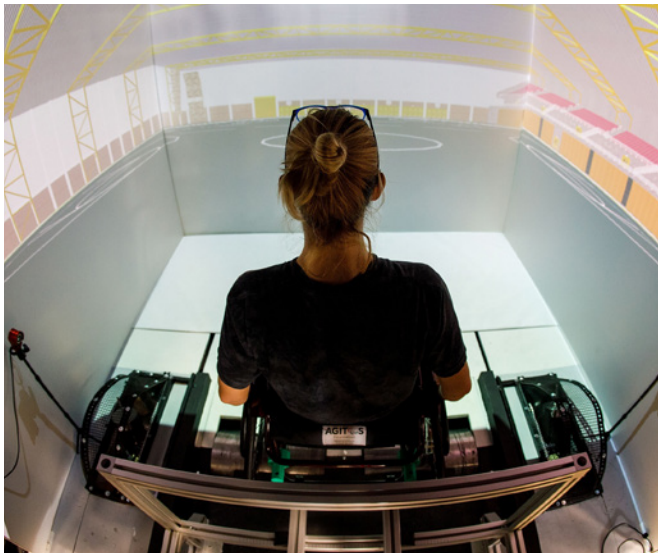
Biomechanics and Low Back Pain

Low back pain (LBP), something that affects almost everyone at some point in their lives, is a condition that creates an enormous burden for health-care systems, individuals and society.

In our quest to personalize back pain care, it is vital that we conduct research to help us better identify spine problems in the individuals who experience them. Because the primary role of the spine is to create a stable platform for daily tasks and movement, our research is currently focused on tests which can evaluate this function. In the same way that diagnostic tests for the heart are aligned with the heart's main function of pumping blood, our novel and developing diagnostic tests attempt to more accurately measure how the spine is able to help you move and work every day.

Biomechanics and Disability

Wheelchair biomechanics involves understanding the most efficient ways in which manual wheelchair users (MWUs) can propel themselves. However, there exists a knowledge void that spawns from the inability to study forces, angles and muscles simultaneously due to technical limitations. And the knowledge we do have is not readily translated into exercise guidelines for MWUs. We intend to fill these gaps by using an immersive, virtual world where the participant can go through similar real-world movements within the stationary confines of a virtual reality cube. Here, we can carry out recordings that would be otherwise difficult in the real-world, including motion capture, electromyography and metabolic analysis.



Cognitive Projections

Our goal through Cognitive Projections (CogPro) is to enhance post-secondary and health-care training by creating cutting-edge, authentic learning experiences in safe and accessible spaces, using affordable virtual and augmented reality simulation technologies. We believe that virtual reality (VR) has the potential to change the face of education and society forever.

We develop our simulations by applying video game development strategies, including programming and digital art expertise. Taking advantage of existing technologies, such as the Oculus Rift, HTC Vive, Google Cardboard and other VR viewers, enables our team to focus on the development of the patient interaction.

Parallel Robotics

When people think of robotics, they often think of robotic arms that move themselves. However, many people don't know that there are robots that can move surfaces. We use these robots, which are typically used to move flight simulators, to understand how musculoskeletal and organ systems work and how they can be manipulated to improve health. Through studies using a unique parallel robot, we are able to better understand joint mechanics and balance and how we can assist those with medical issues such as kidney stones.

ProjectDR

ProjectDr is an augmented reality software platform which enables diagnostic images to be projected onto the skin surface of a patient. This technology also corrects the image to account for distortion caused by skin contours as well as the size and shape of the individual. The software allows for input of any number of 2D or 3D diagnostic image formats while output can be viewed through transparent or projected displays.

For more information about all of our projects, visit uab.ca/rrl.

STUDENTS TAKING STRUCTURED CLINICAL EXAMS WILL NOW BE ABLE TO GET SOME HANDS-ON PRACTICE WITH THE HELP OF ARTIFICIAL INTELLIGENCE

New U of A virtual reality program reduces anxiety and increases abilities for occupational therapy students

Occupational therapy students preparing for their clinical exams are feeling a little less anxious thanks to new virtual reality programming at the University of Alberta's Rehabilitation Robotics Lab.

The Objective Structured Clinical Exam (OSCE) Virtual Reality Program, created by Faculty of Rehabilitation Medicine MSc in Rehabilitation Science student Brendan Concannon, is allowing students to get hands-on exam practice before they complete the real thing.

"The OSCEs are novel experiences for students in health sciences programs," says Concannon, whose project was supervised by Department of Occupational Therapy's Shaniff Esmail and Mary Roduta Roberts. "They feature assessment stations where students demonstrate their clinical skills, providing consultations to mock patients."

During a typical OSCE, students taking the exams enter a clinical room with a standardized patient, an actor who is trained to represent a person with a complex array of health characteristics.

"The student acts as a therapist providing a consultation to the patient, focusing on a holistic approach and completing a thorough investigation of the patient's health."

Assessing patients, standardized or not, can be nerve-wracking, with students expressing stress and anxiety during preparation.

But with the help of a realistic, virtual space, students are able to gain some peace of mind by practicing different scenarios with an interactive avatar.

"Our project data has shown significant results, with a notable difference in anxiety levels between those who practiced with the VR system and those who did not," says Concannon.

The electronic, immersive environment replicates the actual assessment rooms used during the exam, complete with an artificially intelligent examiner and patient, whose movements mimic those of real-life patients.

"The OSCE VR Program uses virtual reality technology to generate an authentic simulation of the OSCE for students to train and get a feel for what the actual exam is like in a safe space," says Nathanial Maeda, a postdoctoral fellow in the Faculty of Rehabilitation Medicine who headed up the project in the Rehabilitation Robotics Lab. "The goal is for exam anxiety to be reduced so students can be more successful."

Although occupational therapy students are the main users of the program, Concannon believes it could be implemented across campus.

"Programming such as this would have promising transferability to other programs that require practical examinations or interviews, such as performance arts, media studies and business, to name a few."

But before there can be more wide-spread application, Maeda says that they hope to improve the program over time so students can get the most out of their studying.

"We plan to enhance the artificial intelligence component using real OSCE data, add more patient scenarios and implement a real-time feedback component. This will give students an even more realistic experience."

CORE PROJECT TEAM: Valery Dufour, Shaniff Esmail, Martin Ferguson-Pell, Nathanial Maeda

EON iCUBE SYSTEM HELPS WHEELCHAIR USERS GET BACK TO MOVING AROUND PAIN-FREE

The Rehabilitation Robotics Lab's wheelchair propulsion simulator helps researchers understand and better treat common upper body injuries

Over 67 million people currently use wheelchairs as their primary means of getting around. For those who use manual wheelchairs, the strain on the upper body can be significant.

The most common ailments seen in wheelchair users reside in the shoulders. Manual propulsion for wheelchair movement can cause strain in the muscles and tendons, especially if the user's resistance level is higher than what is suitable for their strength. Seating and positioning factors can also play a large role in how a person controls their wheelchair and can often put unwanted stress on the upper body.

The Rehabilitation Robotics Lab's EON iCube system provides an immersive, simulated real-world environment for wheelchair users by superimposing the equipment (a manual wheelchair and a built-in treadmill) with an ergometer. This allows users to practice maneuvering their wheelchair through various scenarios, while an ergometer and head movement tracking cameras collect propulsion and position data.

"This 3D space offers a way for researchers to collect metrics that can be used to sequence wheelchair propulsion," said John Christy Johnson, a Master of Science in Biomedical Engineering student currently working in the lab. "It is equipped with motion capture cameras which can collect propulsion kinematics and head movements."

The rolling resistance of the treadmill can be adjusted to suit whatever difficulty level is required—whether it's for a manual wheelchair user with shoulder pain or an elite Paralympic athlete.

The data collected helps researchers understand and better treat common injuries in wheelchair users for they can get back to moving around pain-free.

CORE PROJECT TEAM: Martin Ferguson-Pell, Sydney Hampshire, John Christy Johnson

U OF A ROBOTICS TEAM AND ATB NERD IT UP WITH VR ART AT SUMMER CAMPS

The Rehabilitation Robotics Lab uses art and virtual reality to promote careers in rehabilitation, science and technology

"We really want them to embrace their 'inner nerd' and dive into all things science and rehabilitation," Rehabilitation Robotics Lab Digital Art Director Valery Dufour said, referring to the high schoolers who came to the University of Alberta for part of the ATB Future Transformer Camp this summer.

Teens traded in their sunscreen for science during a visit this summer to the Faculty of Rehabilitation Medicine's Rehab Robotics Lab where they learned about the art and design aspects of rehabilitation medicine—and it's all thanks to help from a virtual, 3D world created by Dufour.

"ATB approached us with their summer camp, as they had heard about the RRL and how we are leaders in using cutting-edge technology to create innovative solutions within the Faculty of Rehabilitation Medicine. We already host numerous tours with Women in Scholarship, Engineering, Science, and Technology (WISEST) and USchool at the University of Alberta to get our young people interested in science and technology, so when ATB proposed we run a segment in their summer camp for 'inspiring Alberta's next innovators,' it was a natural fit."

During the camps, youth are introduced to the latest technology being used for research and treatment in rehabilitation medicine. The hope is that the students will be inspired to pursue careers in STEM and start to think outside the box when it comes to new ideas for health care technology and its uses.

With this in mind, Dufour created a 3D world where students can illustrate their own art pieces, giving them a taste of the versatility of augmented and virtual reality (AR and VR) technologies.

"Our team has created both learning objects and simulations in VR/AR that are currently being used by students at the University of Alberta. In this case, we are teaching kids how to use Google Tiltbrush, a VR drawing application that allows kids to create art in an immersive virtual environment. **We teach them fine motor control skills, how to use the technology, how to create in a 3D space and how to translate abstract concepts into pseudo-physical existence. This gets them familiar with the technologies and also helps drum up some excitement about applying these kinds of innovations in their own future careers.**"

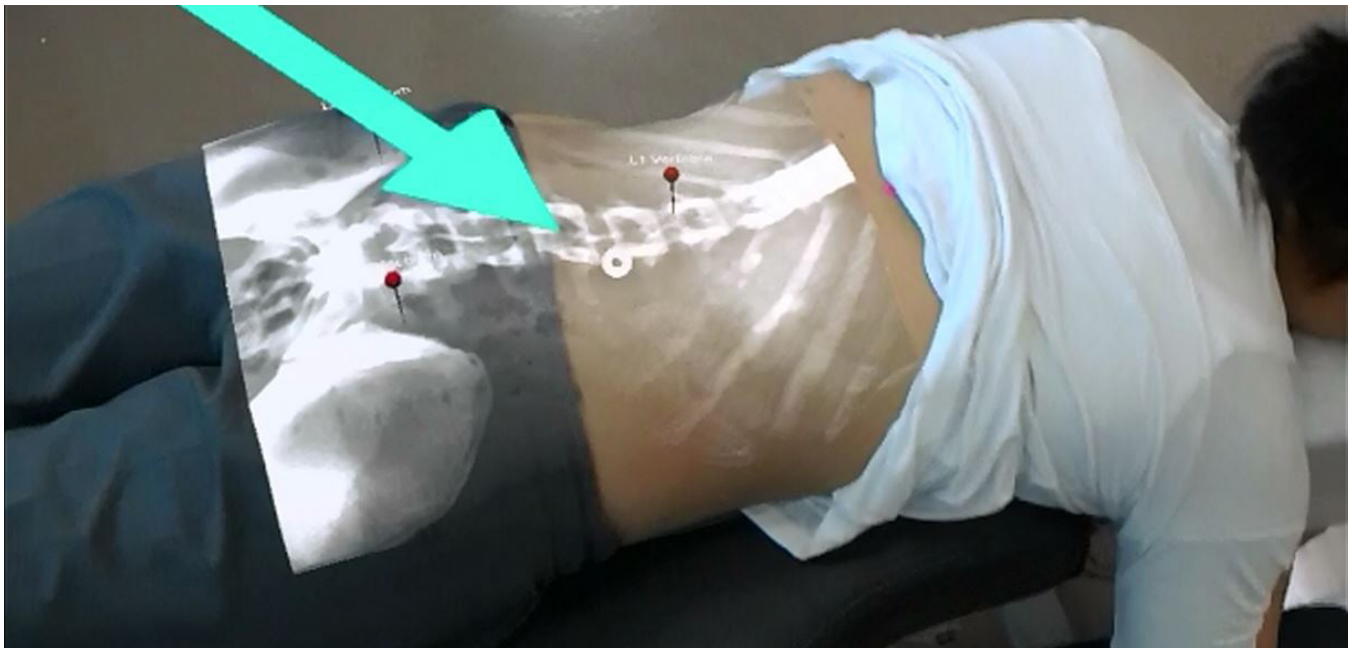
Students also learn how to collaborate in a team setting, which is a vital skill for them to have when pursuing any career path.

"The youth that come through the lab are incredibly bright individuals that deserve the opportunity to grow into the people that they strive to be. We recognize this and believe in their potential. Showing these kids what is up and coming in technology and science and letting them meet with professionals and potential mentors in a collaborative space, it's a priceless experience for them," said Dufour. "This is a sensitive time in their lives—they're just starting to map out their career paths. We hope that the summer camp and the early exposure to what we do will give the students an opportunity to take the classes they need if they want to enter in to the STEM (Science, Technology, Engineering and Math) fields."

Dufour also hopes that by continuing to run summer camps such as this, more kids will be inspired to pursue opportunities not only in STEM, but also in rehabilitation medicine and robotics where these types of tools can also be applied.

"Be innovative and change the world—change people's lives. With this summer camp, we're teaching these students that science can be fun and that technology can be used for things you never thought possible—even art!"

CORE PROJECT TEAM: Emily Armstrong, Courtenay Badran, Valery Dufour, Sydney Hampshire, John Christy Johnson, Nathanial Maeda, Emmanuella Osuji, Andrew Vonow



X-RAY VISION A NEW REALITY, SAYS UALBERTA RESEARCH STUDY

New goggle technology is giving health-care providers the ability to 'see' their patients' spines

Superman might be able to see through buildings, but researcher Greg Kawchuk can see through people.

A recently published University of Alberta study is looking at a new head-mounted goggle technology to reunite patients with their X-ray images.

Kawchuk, a professor in the Department of Physical Therapy, Faculty of Rehabilitation Medicine and co-founder of the Rehabilitation Robotics Lab has been working with Department of Computing Science professor Pierre Boulanger and researchers from the University of Southern Denmark to make X-ray vision a reality.

"I've been following this technology from day one. I knew right away that it could be used to help health-care professionals, such as physicians, physiotherapists and chiropractors, locate anatomy that was not apparent to normal vision. [My team and I] bought the goggles as soon as they hit the market."

While there are several different types of these goggles available, Kawchuk and his team chose to look at Microsoft Hololens for this specific study.

The wearable technology projects a holographic, mixed-reality superimposition of a person's X-ray on their back. Physicians wearing the goggles will be able to see an anatomically correct view of the person's spine, almost as though they are looking right through them. This helps with adjusting treatment and exercise plans.

"Traditionally, educators had to point to where organs were located in the body, or draw images on people's skin so they can imagine where body parts are located," said Kawchuk. **"Now we don't need to do that. We can just put on a pair of goggles and 'see' what's underneath, like true X-ray vision."**

The study conducted by Kawchuk and his team found that the goggles were 73 per cent accurate when it came to locating vertebrae levels in the spine. A total of 13 participants who already had pre-existing spine X-rays took part in the study.

According to Kawchuk, there are positives for both patients and clinicians, but it really all boils down to having the ability to include the patient in their own data.

"The historic disconnect between X-ray and patient is the basis of the well-worn clinical advice to 'treat the patient, not the film.' Disconnected imaging can result in misguided interpretations of the image with respect to the patient."

While the technology will make an impact in the clinical community, there's also room for the tool to be used in an educational setting.

"This is perfect for classroom education. Not just for health-care providers and their patients, but also for students who are going to be entering into the field," said Kawchuk.

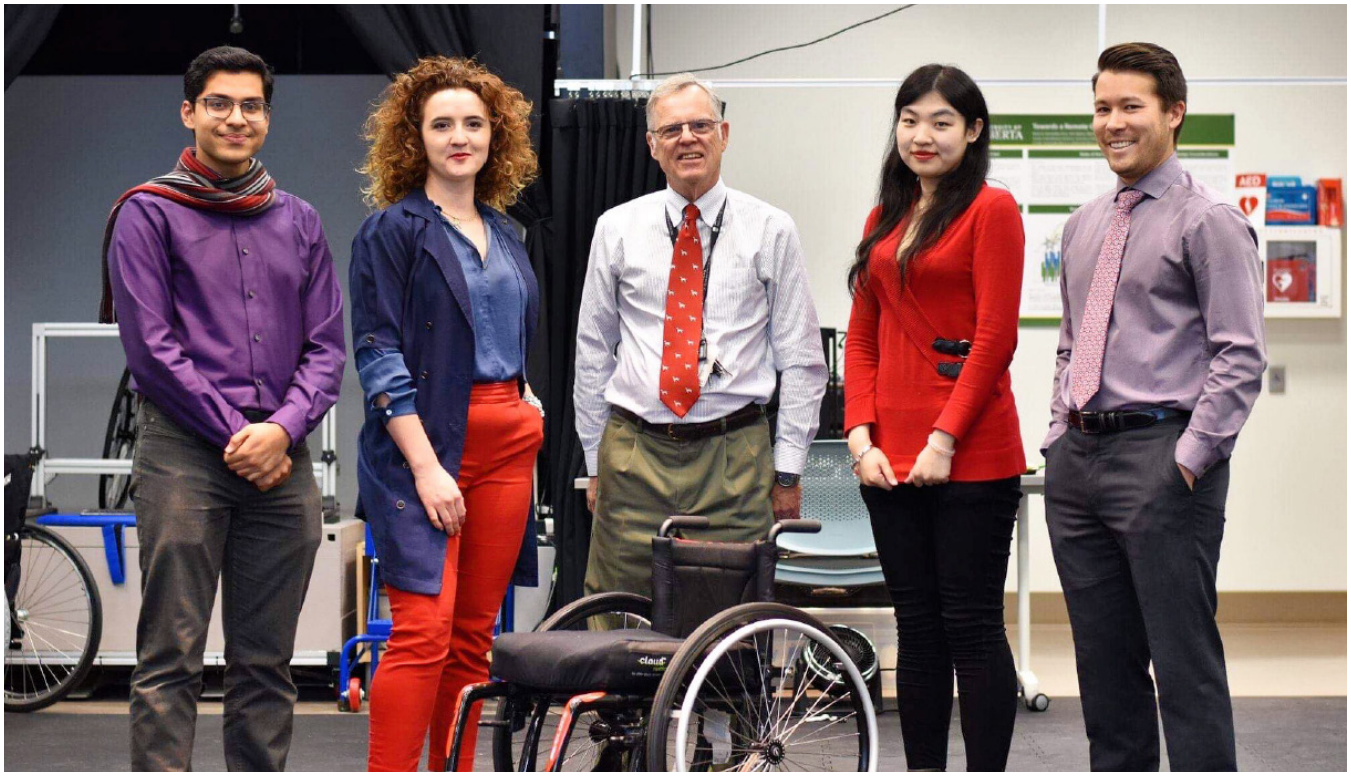
In the long run, augmented reality goggles have the potential to help both the clinician and the patient when it comes to understanding diagnosis and treatment.

"Future plans are already in the works to take the new technology into a clinical environment to see how it can improve interactions between physicians and patients when it comes to explaining imaging results. We're excited to 'see' where it goes."

CORE PROJECT TEAM: Jacob Aaskov, Raymond Guan, Greg Kawchuk

THE STARTUP OF SOMETHING WONDERFUL

The Rehabilitation Robotics Lab has a number of startup companies that were created to meet the growing needs of people in Alberta and beyond. These companies were established with the help of our collaborators, including SMART Network.



Click&Push Accessibility Inc.

In October 2018, the Rehabilitation Robotics Lab incorporated a social enterprise named Click&Push Accessibility Inc. as a spinoff member of the University of Alberta Accelerator at Enterprise Square. This project began with the goal of commercializing our Redliner and exertion mapping technologies, supported by the SMART Network Technology Innovation and Commercialization (STIC) fund and an award from Health City. Opportunities have been developed to create accessibility maps that incorporate data from Redliner and also enable both indoor and outdoor maps to be produced with information about accessibility for a wide range of disabilities and exertion data obtained with Redliner. We have extended this venture to include bicycle users as well. The organization focuses on a bottom-up approach by employing co-creation groups for both wheelchair and bike. The hope is to tailor our technologies to the user.

Click&Push-Bike aims to provide route planning, performance optimization and real-time performance information to bike users and employs three core technologies to do so. These technologies come from Redliner, which consists of exertion maps through our web application and an EMG algorithm that analyzes muscle contractions and determines muscle fatigue levels in real time. The project is currently exploring bikeshare programs and exertion mapping.

Municipalities, including Edmonton, are actively promoting bikeshare programs. To ensure an enjoyable experience for bikeshare clients, Click&Push-Bike provides a means for route planning based on physical capacity. This technology supports urban planners addressing the increasing diversity of cyclists in our cities.

Click&Push-Bike offers the opportunity to produce exertion maps for cyclists. An application integrates muscle fatigue and exertion data to optimize performance. To do so, the cyclist needs to match their metabolic reserves with the exertion challenges that remain on the circuit provided by the map.

Our application can also help cyclists to select their ideal route based off their metabolic reserves and the available exertion data, just as skiers select from blue-, green- and black-level runs.

Another exciting opportunity through Click&Push-Bike is to provide information for competitive cyclists, where the exertion levels of the circuit may be provided for planning and training purposes.

CORE PROJECT TEAM: Martin Ferguson-Pell, Sydney Hampshire, John Christy Johnson, Yilina Liubaoerjijin, Nathanial Maeda

VibeDX

VibeDx Diagnostic Corporation was established as a spin-off from technology created at the University of Alberta. Since that time, the company has won the prestigious VenturePrize in addition to securing funding from various competitive and entrepreneurial sources.

The corporation is a suite of diagnostic technologies for the spine. Our first technology is similar to seismic testing used to locate oil deposits. **VibeDx applies vibrations to the spine to detect the type, location and severity of spinal lesions**. In cadaveric testing published in the Journal of Biomechanics, VibeDx has correctly identified the type, location and severity of 17 different surgically created lesions in 5020/5040 attempts.

In parallel to its use as a diagnostic during surgery, VibeDx is being developed in parallel as a non-invasive technology to assess spine status before and after surgery. A recent clinic trial conducted in the largest database of twins in the world showed that VibeDx is able to distinguish human subjects having spinal lesions from who do not.

Our second technology uses a laser-guided roller to apply pressure to the spine so that the stiffness can be measured. This technology has been assessed for its reliability and has shown in clinical trials that stiffness is a responsive measure that changes in back pain patients that report improvements in disability. Presently, we have nine of these units installed globally and are poised to collect large volumes of spine data for clinical trials.

For more information about all of our startups, visit uab.ca/rrl.

CORE PROJECT TEAM: Anthony Au, Greg Kawchuk

UALBERTA PHYSICAL THERAPY PROFESSOR BRINGS INTERNATIONAL BACK TREATMENT PROGRAM TO CANADA

Training on Feb. 9 and 10 was the first use of GLA:D™ Back in the country

When Greg Kawchuk accepted an invitation to travel to Denmark to be an external examiner for a PhD defense in 2010, he didn't know that eight years later, he would be bringing back a world-renowned osteoarthritis treatment plan—the first of its kind.

But that's exactly what happened.

What started out as a one-time visit to the University of Southern Denmark (SDU) has evolved into an adjunct position that takes him international in May and November of each year.

Over the last year, he has been working with the SDU developers of Good Life with Osteoarthritis: Denmark (GLA:D®) to implement a new trial of the GLA:D™ Back program in Canada. More specifically, in his professional home of University of Alberta, Faculty of Rehabilitation Medicine's Corbett Hall.

"Since my first days at SDU, the collaboration between our two institutions has grown steadily. Two years ago, they honoured me with an adjunct professor position, which has taken our work together to the next level," explains Kawchuk, a professor in the Department of Physical Therapy, Faculty of Rehabilitation Medicine. "Before I knew it, we were working out the details for the first English language implementation of GLA:D™ Back to be conducted right here in Alberta."

The feasibility trial, known as the GLA:D™ Back Pilot, took place on February 9 and 10 at Corbett Hall, with the help of Bone and Joint Canada, GLA:D® Back developers from Denmark, the Alberta Bone and Joint Health Institute, Physiotherapy Alberta, the Alberta College and Association of Chiropractors and Rehab Med's Jackie Whittaker and Allyson Jones. Together, they provided training to physiotherapists and chiropractors from 20 clinics across the province. Typically, once the training is complete, clinicians have two months to run a trial of the program with patients.

"The GLA:D™ Back program has three pillars: patient education, structured exercise and data collection," says Kawchuk. "It's really important that as researchers, we have that data component to see how patients are responding. At the end of the day, we can't hope to change what we can't measure."

Once officially implemented, the program will run as a group class format with two education sessions and eight weeks of structured exercises. At the end, participants will be given a final evaluation to see how their pain is being managed.

Kawchuk believes the standardized package approach will help get clinicians on the same page.

"The education component about back pain is really critical to the program. Lots of people with back pain and those who treat it have a wide range of ideas about what back pain is and isn't. This program, which is derived from the latest evidence, creates a tidy package easily adopted by both participants and clinicians that provides a better understanding of back pain and what can be done to improve function, movement and discomfort," says Kawchuk.

"In the related GLA:D™ Hip and Knee program, we're beginning to see that patients who take the program often stick together to train even after their eight weeks are over. They continue to support one another, completing their exercises every week. So really, there's two great outcomes of this program: standardized treatment in the interim and support group creation in the long term."

While Kawchuk coordinated the training, his master's student James Lemieux took on the study as his master's project. Once the study has been complete, the hope is that a provincial roll out will happen fairly quickly.

"We're really hoping we can get this going, data permitting," says Kawchuk.

CORE PROJECT TEAM: Greg Kawchuk, James Lemieux

We need YOU

The Rehabilitation Robotics Lab is always searching for partnerships to inspire us and allow us to continue to change the face of rehabilitation.

TRAINEES

We always have opportunities for students of any level to come and learn in our lab. We accept students in the following positions:

- PhDs
- Summer volunteers
- Co-op students
- Master's students
- Research assistants
- Semester volunteers

At the Rehab Robotics Lab, you have a unique opportunity to have your ideas heard and supported! If you are interested in joining us in the lab, please contact us at **frmrobot@ualberta.ca**.

BECOME A DONOR

Without the help of our generous donors, we wouldn't be able to make the groundbreaking discoveries in technology that we do. If you would like to give to the Rehab Robotics Lab, please contact John Voyer, Assistant Dean, Development at **jvoyer@ualberta.ca** or **780-248-5781**.

A **SPECIAL THANK YOU** to our current donors. You have helped us more than you can imagine!

TOURS AND STUDENT WORKSHOPS

If you would like a tour or to conduct a student workshop in our lab, please contact **frmrobot@ualberta.ca**. The lab is open to student summer camp sessions, such as those run through ATB, LEGO League, and the U of A's STEM Summer Camp and USchool.

ROBOTICS ON THE RISE

LAB AT-A-GLANCE

- Featured in over **20 media stories**, including those published through CBC Edmonton, Global News and Edmonton Journal

- Held **student workshops** for various youth groups, including: USchool; Edmonton Public Schools; LaGlace School; Women in Scholarship, Engineering, Science and Technology (WISEST); and ATB's Future Transformer Camp

- The Click&Push team took home a **third place** win in the 2019 IDeA Competition (highlight yellow 2019 IDeA Competition) and received a **TEC Edmonton 2019 Innovation Award**

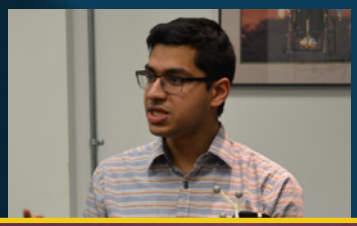
- **Competed as finalists** in the University of Alberta International's World's Challenge Challenge, an initiative that invites student teams to propose an innovative solution to a major global issue

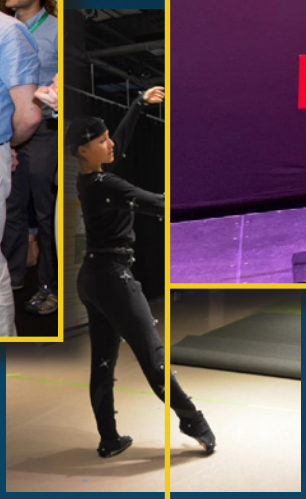
- Participated in and helped coordinate **VR After Dark**, a showcase of innovations in learning through virtual and augmented reality technology. This event was a collaboration between NorQuest College, Health City, University of Alberta, Concordia University and NAIT.

Worked with and provided tours for:

- Alberta Health Solutions
- ATB Financial
- Canadian Armed Forces
- Glenrose Rehabilitation Hospital
- Government of Alberta
- Loughborough University
- Pfizer Inc.
- Spinal Cord Injury (Northern Alberta Treatment Centre Society (SCITCS)
- University of Alberta (various faculties)
- Stollery Children's Hospital
- Wheelchair Sports Alberta
- Royal Alexandra Hospital
- Steadward Centre

Hosted Alberta Minister of Advanced Education **Demetrios Nicolaides** and UAlberta President **David Turpin**





Welcomed **Aron Downie from Macquarie University, Australia** for his talk, 'Red flags: When is back pain something more?' and **Vicki Tolfrey from Loughbough University, UK** for 'Science of Wheelchair Sport'

Participated in: **Rehab Week 2019**, one of the largest rehabilitation conferences in the world; **2019 Canadian Association of Occupational Therapists (CAOT) Conference; University of Alberta's Festival of Health, Festival of Teaching and Learning and Campus Accessibility Open House; Bike 2019**, a conference to explore and engage in a conversation about the research, policy and practice around cycling as a mode of active transport; **TEDxUAlberta; FIRST LEGO® League**; and **MORE!**

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REHABILITATION ROBOTICS

A LOOK INTO THE FUTURE OF REHABILITATION TECHNOLOGY

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