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innovations magazine

Fall/Winter 2014

eHEALTH:

LEVERAGING NEW TECHNOLOGIES TO PROMOTE HEALTH

Also

REHABILITATION ROBOTICS

POWER CONVERSION FOR RENEWABLE ENERGY SYSTEMS

HIGH DYNAMIC RANGE VIDEO

SPORTS PLAYER TRACKING

and more…

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THE UNIVERSITY OF BRITISH COLUMBIA

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director's desk }

Welcome to the latest edition of ICICS *Innovations* magazine. I would like to take this opportunity to introduce you to a new model for collaborating with industry developed by ICICS that takes advantage of our unique pan-university status.

Under this model, a blanket intellectual-property agreement is negotiated between the company and UBC, freeing company managers of the need to negotiate one-on-one agreements with individual researchers. ICICS works with the company to define one or more broad-based research projects in support of their R&D goals. We then assemble research teams from our 160-strong cross-faculty membership, pursue additional government funding, and manage the projects. Tangible results are realized for companies, with direct benefits for their innovation strategies. Researchers and students gain support, industry exposure, and perspective.

This new approach has led to the ICICS/TELUS People and Planet Friendly Home sustainability initiative, which we profiled in the Fall/Winter 2012 issue. This broad-based endeavor involves 25 professors and 37 students from 4 different faculties, and is supported by a 6-member industry consortium led by TELUS. The project continues to grow, attracting additional industry and government funding. A site has been selected in the central campus to build a prototype home and broaden the scope of the integrated research efforts.

We look forward to additional meaningful collaborations with industry emerging from this new collaboration model. In the meantime, I hope you enjoy the sampling of UBC research achievements we provide here.

Panos Nasiopoulos, ICICS Director

eHEALTH: LEVERAGING NEW TECHNOLOGIES TO PROMOTE HEALTH

BY SHAWN CONNER

WITH THE FAST PACE OF TECHNOLOGY DEVELOPMENTS IN THE AREA OF HEALTH CARE SERVICES DELIVERY, HOW CAN STUDENTS, PROFESSIONALS AND PATIENTS KEEP UP?

This is one of a number of questions facing Dr. Kendall Ho. A professor in the Department of Emergency Medicine, Ho is also a Director of the eHealth Strategy Office in the Faculty of Medicine at UBC. As Director, Dr. Ho leads an interdisciplinary team of researchers conducting research into eHealth and technology-enabled knowledge translation. They are focusing on how to best harness modern technologies to enhance health services and accelerate the incorporation of the latest health evidence into routine practices.

"We are very interested in understanding how modern information technologies, like mobile phones, tablets and computers, can be used optimally for healthy pursuits," Dr. Ho says. "The motto of the strategy office is 'Health Interconnected: Connecting People to Better Health.' We use the word 'better' as a verb."

The research helps policy-makers like the B.C. Ministry of Health's Patients as Partners branch develop strategies to engage the general and multicultural public in using technology for their own health. "And then we carry out education for health professionals, including medical students," Dr. Ho says. The eHealth Strategy Office opened in September 2008. At that time, the Dean of UBC's Faculty of Medicine appointed Dr. Ho as Founding Director. But Dr. Ho's work in eHealth had begun before that, in 2003, with the use of videoconferencing for Emergency Health Services.

Of course, we've come a long way since then. "Technologies have come down significantly in costs and gone up in terms of ease of use," he says. "The general public has increasing understanding and expectation of using technologies in health. As technologies have become more mainstream, governments and health organizations have been increasingly adopting eHealth programs. Health professionals are becoming much more adept at using technology."

eHealth Advantages

Using technology to promote health offers advantages across the sector. For health care professionals, technology offers the opportunity to measure, quantify, analyze, and disseminate research and knowledge in unprecedented numbers and specifics. Meanwhile, health consumers are finding useful information to support their own health, and have become better able to connect both with other patients with the same diseases, and with health professionals. And government can use solid health data in terms of understanding disease patterns and health trends and where to put its resources. As an example, Dr. Ho cites the rising number of people with diabetes, and the subsequent rise in costs of care. "How do you dedicate resources appropriately to the type of services needed?" he asks. Knowledge from eHealth initiatives can help policy-makers make these types of decisions.

Technology also offers challenges, however. "Is the information accurate?" Dr. Ho says. "How do you deal with inaccurate information? How do you make sure the information one obtains is appropriate for that particular individual? How do we, in this new environment, form this health professional–patient relationship, so that we can support each other?"

Diabetes Management

Currently, Dr. Ho is spearheading several eHealth-related projects that look at these and other eHealth challenges. One project, on diabetes, is supported by the Lawson Foundation, a Canadian philanthropic organization. The project helps people with diabetes and caregivers manage the condition using sensors, social media and text messaging. The project's participants use the sensors to measure their weight, blood pressure, and glucose level. Social media links them to their fellow patients and family members to discuss the best ways to manage the disease. Supportive tips are provided by health professionals via text messaging.

This research has found that patients who follow the program are better able to control their blood pressure, and improve their A1C levels, an indication of how well they are able to control their glucose levels over time. "They actually have some desirable weight reduction," Dr. Ho says. "They found that the system is very supportive to their health. At the eHealth Strategy Office, we don't invent the sensors ourselves, we don't invent social media, but we apply these different kinds of technology in the health context to support patients."

Engaging Communities

Dr. Ho is also working with the Ministry of Health's Patients as Partners initiative on two programs. One is the Intercultural Online Health Network (ICON). It uses multimedia channels such as live forums, Web 2.0, YouTube, and social media to engage the Chinese and South Asian general public, and to present material in their native language to support them in chronic disease management. "We found that seven out of ten people who attend one or more of our different media channels want to make a big change in their lives to improve their health," Dr. Ho says. "Three out of four people want to make at least a small change to live a healthier life." Another sign of success: some temples in South Asian communities have begun changing their menus to reflect diabetes-related concerns.

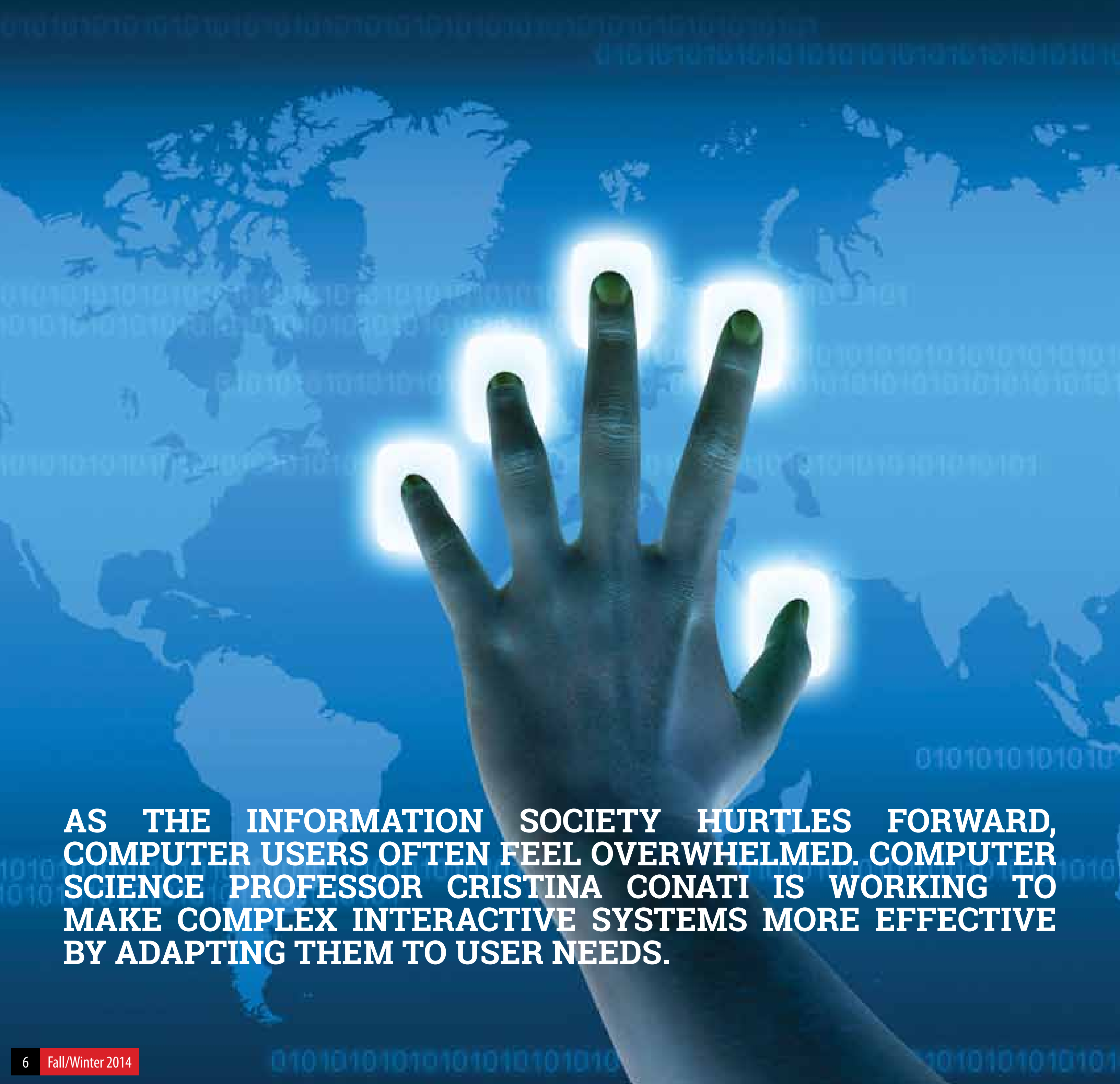
Another collaboration with the Ministry of Health looks at methods to introduce eHealth technology to the general public. In B.C., patients can now access their own lab results, on the same day they take the tests. More and more of these tools, including commercial, health-related apps, are coming.

"Downstream, there will be more opportunities for patients to access their own information," Dr. Ho says. "In the meantime, how do we make the general public aware of these tools, and how do we make sure we work with them so they use these tools appropriately?"

Although eHealth has been around for a long time, in some ways we're just beginning to understand how to best utilize it. "It's not only about reading the information, but knowing if it's helpful," Dr. Ho says. "How do we work with the general public in raising eHealth literacy?"

For more information, contact Kendall Ho at kendall.ho@ubc.ca

Adaptive User Interfaces



AS THE INFORMATION SOCIETY HURTLES FORWARD, COMPUTER USERS OFTEN FEEL OVERWHELMED. COMPUTER SCIENCE PROFESSOR CRISTINA CONATI IS WORKING TO MAKE COMPLEX INTERACTIVE SYSTEMS MORE EFFECTIVE BY ADAPTING THEM TO USER NEEDS.

In the field of user-adaptive interfaces, there are two main areas of inquiry, spanning disciplines that include artificial intelligence, cognitive science, and human–computer interaction (HCI). In the first, a user model has to be established, based on the user's interactions with the system—the machine needs to learn something about who it is dealing with, using artificial-intelligence techniques. In the second, the system needs to adapt to the user's perceived needs by, for example, changing how the information is presented, customizing interface functionalities, or providing explicit suggestions that might help the user. Conati believes that these user-adaptive interactions must strike a balance between automated adaptations and those controlled by the user. "You can see it as a continuum," she says. "At one extreme, the machine understands what is going on with the user and is in complete control of how to adapt to it. At the other, the user does all the work and has good tools to customize the interface as they like. Neither approach works perfectly, so we aim for a 'mixed-initiative interaction', or a balance between the two."

Adapting Visual Information to the User

The exponential increase in the amount of widely available digital information made possible by technological advances has created a need for new tools to facilitate its interpretation, such as visual analytics. Conati has been exploring user-adaptive information-visualization scenarios in some of her recent work, where the user interprets data that are presented visually. Since different users have different visualization preferences and abilities, it can be useful to alter the visualization accordingly. In developing these visualizations, Conati collaborates closely with fellow UBC Computer Science professor Giuseppe Carenini. UBC cognitive psychologist James Enns has lent his expertise on user study design, and the selection of user parameters to guide the adaptations—Conati is currently focusing on perceptual speed, visual working memory, and verbal working memory, and may consider additional features in future work. Through extensive lab studies, these features are used to develop user models, which help guide real-time adaptations as the user interacts with a visualization. Gaze data obtained by an eye tracker, for example, may indicate that a user has low perceptual speed, since they refer frequently to additional information—such as a graph's legend—to interpret patterns in visual data. In combination with their interactions with the system, the user can then be "classified" and the visual information modified accordingly.

While real-time user-adaptive interactions are the ideal, Conati concedes that again a balance must be struck, in this case between "making an early prediction based on developed user models in order to help the user as soon as possible, and acquiring enough data to make it fairly accurate. The ultimate user model would know as many things as possible about the user: emotional reactions, perceptual abilities, the task they are working on, and their expected performance, in order to adapt and personalize the interaction."

Urban Planning Applications

Conati collaborates with Vancouver-based company Metroquest, which has developed a community-engagement platform for planning projects that is used by municipalities, as well as architectural and engineering firms, across North America. The visually based platform is designed to solicit public input on planning options, such as regional transportation plans, both online and in public kiosks. The company is providing system access and technical support to Conati, to help her develop adaptations that will keep their target audiences engaged, limiting complication as necessary and responding to user preferences. As a testbed, Conati is using a customized Metroquest system to canvass student opinion regarding public transit improvements to UBC.

Potential real-world applications of Conati's work are growing daily. "We are moving toward the big data era," she observes, "where we are going to be surrounded by data that need to be interpreted by a wide range of individuals. Health-tracking data, for example, will need to be personalized in such a way that anyone can benefit from it, whatever their skill level."

For more information, contact Cristina Conati at conati@cs.ubc.ca

Rehabilitation Robotics for Stroke Victims

by Shawn Conner

Mechanical engineering professor Machiel Van der Loos is using robotics to help people recover from debilitating impairments.

How do you make rehabilitation involving, and entertaining? "Rehabilitation is really hard work," Van der Loos says. "We need to give people reasons to keep at it. There's only so much you can do intrinsically—we can encourage them with, 'You have to get better, stronger.'"

Van der Loos and his team in the RREACH lab, which is part of the CARIS (Collaborative Advanced Robotics and Intelligent Systems) lab at UBC, have come up with a novel solution: the FEATHERS (Functional Engagement in Assisted Therapy through Exercise Robotics) project, which uses video games and social media to facilitate and encourage physical rehabilitation.

By altering the hardware of store-bought controllers and the software "between the measurement of the position and movement of the cursor," Van der Loos and his colleagues have made it necessary for the player to manipulate two controllers simultaneously, thus ensuring that both arms are employed equally.

"The software takes bimanual motions and maps those to the movement of one cursor," Van der Loos says. "If you have one weak and one strong arm, and you're asked to do bimanual motions, you're likely to do smaller-range, less precise motions with your weak side. The cursor gets mapped to the hand that moves the least to promote making your hands move in an even and symmetrical way to get the cursor to move."

The target beneficiaries of the project are survivors of stroke and teenagers with cerebral palsy. As of publication, the project is in the midst of its final testing phase, a six-month design study.

Another important component of FEATHERS is the social media aspect. Players are able to log in and share results not just with their physiotherapists but also other players.

"Having some extrinsic motivators like games and social media are really powerful tools to keep people engaged," Van der Loos says.

To change the shape of the controller itself, FEATHERS brought in an Emily Carr design team to create a new shell "more appropriate to the kinds of movements used in physical therapy. The shape is easier to put into a hand that may be perennially clenched due to flexors stronger than extensors [a result of stroke]."

RREACH (which stands for Robotics for Rehabilitation, Exercise and Assessment in Collaborative Healthcare) is also collaborating with other UBC labs and departments on FEATHERS, including the Department of Kinesiology and the Department of Physical Therapy.

"Many people who live with an impairment don't have a therapist," he says. "So they use whatever they can glean off the Internet, or they depend on however hard their parent or spouse pushes them to get better. But the Canadian healthcare system has nothing dialled in for the kinds of repetitions that are needed to effect some change. You need thousands and thousands of repetitions. In gaming, you get thousands and thousands of repetitions."

Since the benefits reside in using the controllers and not in the games themselves, anything from popular titles like Candy Crush Saga and Farmville to more complicated fare, like first-person-shooter-type games, can be played using the modified system. "We're saying, 'Play whatever you want. Get a handful of games you like, and include the types of movements that are going to further your rehabilitation so there's carryover to your daily tasks.'"

Standing Balance and Sit-to-Stand Research

Besides FEATHERS, Van der Loos is engaged in a number of other robotics-and-rehab projects. One is STARR (Standing-balance Training and Assessment using RISER), which uses a robot to develop new therapies to achieve standing balance. That robot, RISER (Robot for Interactive Sensory Engagement and Rehabilitation), measures and can control standing balance.

"It's a way of exploring the human sensorimotor systems, and how all of these different inputs are integrated to perform what we consider to be really mundane tasks," Van der Loos says.

The research can be used to help people who have trouble with balance, including stroke victims, diabetics, or people who have other neuropathies. Van der Loos is working with colleagues from the Department of Physical Therapy, including a standing-balance group run by Professor Jayne Garland.

Van der Loos is also involved in sit-to-stand asymmetry research. Still in its early stages, the sit-to-stand research uses a one degree-of-freedom robot to assist individuals in the process of getting up from a chair. The hope is that the results of the research will aid hemiparetic stroke victims in using both weak and strong sides to stand from a seated position.

Another area of research is investigating ways for robotics to help people with neurological impairment, often resulting from stroke. Such individuals, Van der Loos notes, often think they are reaching in a straight line when they are not.

"The goal of a lot of robotic therapy is getting people to see what a straight line is," he says. "What works best is to accentuate the error by putting up a forcefield perpendicular to the motion."

Van der Loos is also overseeing research by his doctoral student Bulmaro Valdés on physical compensation, specifically trunk compensation. The idea is to help stroke victims reduce reliance on the non-damaged parts of the body, again with the goal of speeding up rehabilitation.

While much of his work is designed to help people recover from debilitating impairment, there is another area of interest for Van der Loos—a somewhat knottier, even more philosophical one: robo-ethics.

"For example, when is it appropriate?" Van der Loos asks, "given the social context, for a robot to enter an elevator? How does it know? What ends up being the most efficient, or least error-prone set of conditions for the interaction between human and robot?"

For Van der Loos, and for robotic research in general, this is one question that might never entirely be solved. But the potential benefits of robots in rehabilitation are tangible, and are just starting to be understood.

For more information, contact Machiel Van der Loos at vdl@mech.ubc.ca

POWER CONVERSION FOR RENEWABLE ENERGY SOURCES

Much attention has been paid in recent years to renewable sources in the push toward a more sustainable energy supply. Technologies for efficiently converting power produced by solar, wind, tidal, fuel cell and other sources into a usable form, however, remain in their infancy. Electrical and Computer Engineering professor Martin Ordonez has an ambitious research program underway to address this deficit.

Ordonez, who is the Canada Research Chair in Power Converters for Renewable Energy Systems, moved to UBC from Simon Fraser University in 2012 in part because of UBC's emphasis on sustainability. The "Campus as a Living Lab" initiative holds particular appeal for him, as it provides a highly varied testbed for validating new power conversion techniques emerging from his lab. Over the next few years, the initiative will allow Ordonez to integrate novel technologies into the campus grid, starting with a building-scale energy system controller for the UBC Kaiser Building.

One of the reasons there hasn't been more applied academic research on renewable power conversion is the prohibitive cost of outfitting a lab. The suite of necessary equipment, from battery backup systems to industrial-grade converters, is simply too expensive for most researchers to purchase and keep up to date. Ordonez's strong industry connections, including Alpha Technologies Ltd., Powertech Labs (BC Hydro), Delta-Q Technologies, and Corvus Energy have enabled him to equip UBC's state-of-the-art Alpha Lab and assemble a comprehensive team of graduate students and research staff. He sees his industry support combined with more traditional academic funding as making for a healthy research environment. "It's a marriage between colleagues within the university and outside," he says. "It helps to attract good students, when you have a program that integrates real company needs with advanced research. We like getting engaged in research areas that are not an immediate need for a company but may be implemented within a three- to ten-year timeframe."

Technical Challenges

Ordonez's long-term goal is to establish a modular, flexible, controllable, and scalable conversion architecture for different renewable energy systems. A number of complex problems need to be resolved in realizing these architectures. At the scale of a condominium building, for example, there may be a need to extract the maximum power possible from photo-voltaic panels on the roof or fuel cells in the basement; store it in lithium-ion batteries using a battery management system tuned for efficient charging; supply energy to and draw energy from electric vehicles in the parking garage; or perhaps convert the entire building to DC for more efficient energy consumption and fewer losses. The system must be kept flexible, modular, and scalable, so additional components may be added as required, or for use in other contexts using other energy sources.

Such a building-scale set-up would be beneficial to the utilities, as it would contribute to the "smartness" of the power grid, without relying on consumers to change their behaviour. Peak demand periods could be flattened out by drawing on local building energy sources, thus avoiding brownouts or the need to switch on additional generators. Also, as Ordonez points out, "the building would consume energy with very low harmonic distortion and a good power factor, meaning a saving for the utility on transmission and distribution losses. The building could be made a very good citizen in terms of energy consumption."

Toward Distributed Power Generation

Most renewable energy sources are inherently variable, due to fluctuating winds, tidal currents, solar radiation, etc., while consumers want instantaneous response. Storage systems are therefore a necessary component of efficient renewable energy systems. Also, as Ordonez points out, "Every source has some benefit, but also poses unique challenges, with very specialized power conversion requirements." Wind generation, for instance, produces power with variable frequency and amplitude, so it must be converted to DC to be usable.

"I would like to see modular power conversion that is flexible enough to be plugged in almost anywhere."

Extracting, converting, conditioning, storing, and integrating power from a variety of different sources in real-time so that it is accessible to users on demand is difficult enough on a small scale. At the scale of the grid, the challenges become that much more demanding. Yet Ordonez sees this as the way of the future, as do his industry partners such as Alpha Technologies. "We should be able to benefit from small power generation," he maintains, "harvesting everywhere, in a distributed, less centralized fashion. I would like to see modular power conversion that is flexible enough to be plugged in almost anywhere."

With less than 0.9% of worldwide energy consumption in 2011 derived from renewable sources, Ordonez's flexible, modular approach may be the way to go.

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High Dynamic Range Video

Delivering the "Wow" Factor

High dynamic range (HDR) video content is currently attracting the attention of international standardization bodies such as the Motion Picture Experts Group (MPEG), as technologies to capture and display HDR mature. The uncannily lifelike appearance of HDR content—its wow factor—results from its approximation of the range of contrast and colours, or dynamic range, we can perceive in the real world. The human visual system at the limits of perception can accommodate a dynamic range of ten orders of magnitude (10^{10}), with a functional range of about six orders of magnitude. Conventional low dynamic range (LDR) displays. Including current TVs and computer monitors, however, have a range of roughly two orders of magnitude. It's a limitation we've come to accept as the norm, and so when we are exposed to the level of detail that HDR content reveals to us, it seems eerily lifelike, akin to the difference between black and white and colour.

High dynamic range will be a familiar term for many smartphone users, as it is often an available camera option. When selected, two images with different exposure times are taken, and then merged to create a significantly higher range of contrast than is available in a single image. Capturing HDR video content is, however, much more difficult, since two video streams at different exposure levels must be seamlessly merged to create the desired effect. High-end commercially available cameras, such as the RED camera, are capable of capturing HDR video content, but are very expensive and beyond the reach of the average consumer. HDR displays are still in the prototype stage.

Investigators in the ICICS Digital Multimedia Lab are addressing the many technological hurdles that must be overcome in order to deliver high dynamic range video content to consumers, from capturing, processing, and compressing/transmitting, to displaying. There is a general effort internationally to develop techniques for displaying HDR video on existing low dynamic range displays (e.g., TVs and computer monitors). This involves selecting those components from the HDR video that can best be reproduced on a conventional display, so that the viewer benefits from an HDR-like rich viewing experience. High dynamic range images prepared for printing (as seen in the photo on page 12) roughly approximate the appearance (and advantages) of HDR content shown on an LDR display using these techniques.

It is envisioned that the necessary processing would happen in a set-top box, or perhaps a chip in new televisions or displays. If these technologies prove sound, we may be viewing a version of high dynamic range content on our TV sets within the next five years.

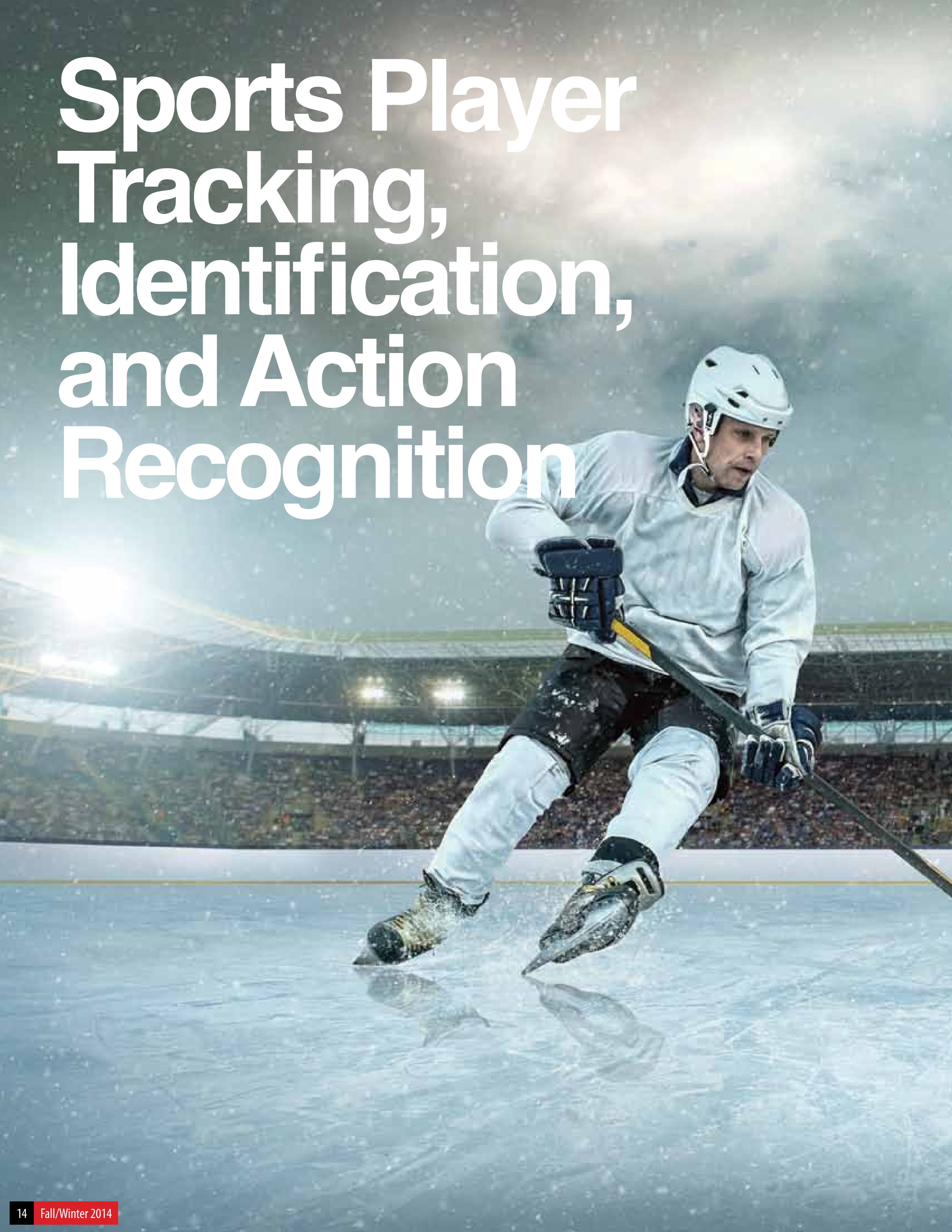
For more information, contact Mahsa Pourazad at pourazad@icics.ubc.ca

LDR image

HDR image

“It’s a limitation we’ve come to accept as the norm, and so when we are exposed to the level of detail that HDR content reveals to us, it seems eerily lifelike, akin to the difference between black and white and colour.”

Sports Player Tracking, Identification, and Action Recognition



In the 1970s, Toronto Maple Leafs head coach Roger Neilson became known as "Captain Video" for his extensive use of videotape as a coaching tool. Technological advances since then have made video analysis less labour intensive, with major contributions from computer vision expert Jim Little and his colleagues in UBC's Laboratory for Computational Intelligence (LCI), in automated player tracking, action recognition, and identification. Once fully implemented, advances such as these will make it possible to search and select video segments featuring aspects of the game that coaches may want to emphasize in a practice. Video assistants would no longer have to pore over footage following a game to manually organize it.

Automated tracking and identification of sports players, as well as recognizing their actions, presents unique research problems. Tracking pedestrians in a mall, for example, is less difficult since their movements are more predictable. The monitoring cameras are usually stationary, making it easier to isolate moving persons in the foreground. Sports videos, however, are mostly captured by panning, zooming cameras, making it harder to distinguish them from a background that also appears to be moving. In addition, players are often bunched up (as in hockey), their faces obscured, their jersey numbers hidden, and their movements very rapid, causing blurring in the video.

"Training data is one of the key problems in model learning."

Semi-supervised Learning

Sports does, however, have a "narrow semantic space," as Little points out. Players' activities are largely confined to those you might expect in a game. Also, teams have a given player line-up that remains fairly consistent throughout a season, making it possible to prepare training data offline. Little does so by having his graduate students draw "bounding boxes" around players and tagging them with the player's name in a training video, which becomes the template for tracking the players in a test video. Since the players' shapes change throughout the game according to their actions, the templates must be continually updated, using machine-learning techniques. Thousands of player features, such as small patches of texture and colour, are automatically generated as the player is tracked. When combined and related to the offline tagging, they form a classifier that enables automated identification of players regardless of whether or not their faces or jersey numbers can be seen.

This combination of manual and automated learning is known in the field of artificial intelligence as "semi-supervised learning". "Training data is one of the key problems in model learning," Little says. "We start with a small nugget of labelled data and see how far we can extend it." Little incorporates play-by-play information to narrow the variable space, so the system knows which players are on the ice/court/field at a given time.

Estimating Pose

Currently, Little is focusing on pose estimation as a means of understanding a player's actions. Many state-of-the-art systems identify pose in individual frames, by fitting a skeleton to the player. Little is incorporating movement by adding pose information from subsequent frames to confirm the initial pose prediction. His work in this area is also finding application in other areas, including the ICICS People and Planet Friendly Home sustainability initiative (see *Innovations*, Fall/Winter 2012). Little is looking at monitoring the pose of occupants in a non-intrusive way (where the video is not stored), to detect anomalies such as falls. This work is complicated by the fact that the home is a far more varied environment than the sports arena, with a much wider range of activities. The setting must be taken into account when assessing the meaning of an individual's pose, as well as their health profile. A certain pose would be expected, for example, when a person is loading a dishwasher, but an alert should be triggered if they appear to fall while doing so, particularly if they are elderly.

Other applications of Little's work include mobile robotics, where the robot needs to understand its environment and the actions of nearby individuals in order to navigate safely.

For more information, contact Jim Little at little@cs.ubc.ca

MAGIC: 25 Years Later

by Siobhán McElduff

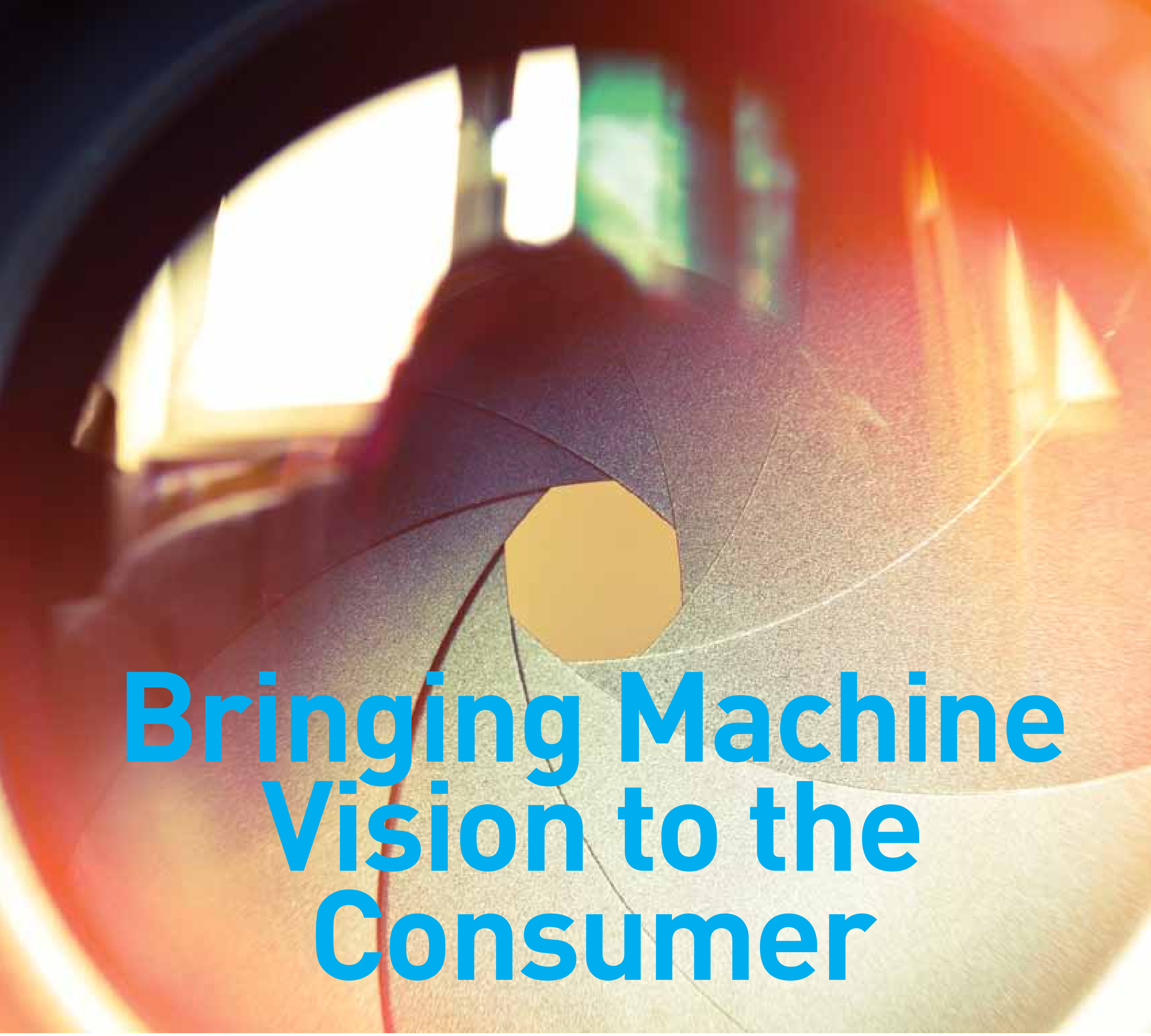
2015 will see the twenty-fifth anniversary of UBC's Media and Graphics Interdisciplinary Centre (MAGIC). Founded in 1990 under the directorship of Computer Science professor Kellogg Booth, its debut at UBC came one year before CERN (the European Organization for Nuclear Research) hosted the world's first website, and two years before the first photograph was posted to the Internet (also by CERN). MAGIC's mission was—and is—to foster research in media technology in support of economic development in British Columbia, and it has adhered to this even as what is meant by media technology is no longer recognizable as the entity it was in 1990.

What has made and makes MAGIC special is its interdisciplinary, innovative approach, which brings together researchers from computer science, engineering, medicine, music, psychology, education, archival science, history, archaeology, and more—in other words, from the entire gamut of UBC's faculties and departments. (Recently, MAGIC has been under the interim directorship of Siobhán McElduff, Associate Professor in Classical, Near Eastern and Religious Studies. MAGIC's Associate Director is Brian Fisher, Associate Professor in the School of Interactive Arts and Technology, and in the Cognitive Science Program, both at Simon Fraser University—a testament to MAGIC's diverse interests and reach.)

Current projects reflect MAGIC's interdisciplinary and innovative ideals: the Canadian Environmental Health Atlas; the BC Child Injury Research and Prevention Network and a range of other visual analytics projects under the supervision of Brian Fisher; the first wearable technologies group at UBC, created by Junia Anacleto, Visiting Peter Wall Scholar and Associate Professor in Human–Computer Interaction at the University of San Carlo, Brazil; the laptop orchestra; an augmented reality app for a Bronze Age site in Cyprus in partnership with NGRAIN Corp., Vancouver; a multilingual tool for creating and assessing philosophical arguments; the Global Legal Identity Watch; and the Digital Salon, a group of researchers in the Arts who use and develop computational tools.

Additionally, as part of its mandate to encourage innovation at UBC, MAGIC recently launched the I3 (idea, innovation and inaugurate) Challenge, in conjunction with Mark Salopek of the GRAND (Graphics, Animation and New Media) national research network. This challenge, aimed at graduate students, is now in its second round, with members of the first intake already in discussions with investors about their projects.

For more information, contact Siobhán McElduff at siobhan.mcelduff@ubc.ca



Bringing Machine Vision to the Consumer

NZ TECHNOLOGIES INC. (NZTECH) IS AN ICICS-INCUBATED START-UP COMPANY THAT DEVELOPS INTELLIGENT DEVICES FOR SAFETY AND INTUITIVE HUMAN-MACHINE INTERACTIONS IN THE AUTOMOTIVE, RESIDENTIAL, AND CLINICAL SECTORS.

President and CEO Nima Ziraknejad, who founded the company in 2009, believes that consumers could benefit more from sensing technologies, particularly machine vision, than they have. As an industrial partner in a research project sponsored by the AUTO21 Network of Centres of Excellence, NZTech is working to commercialize an adaptive and automatic head restraint, or headrest, system that helps prevent whiplash injuries. Ziraknejad was heavily involved in the underlying research during his PhD studies, developing a hybrid sensor array that adapts the head restraint position to the location and orientation of the driver's head, in accordance with guidelines from the Insurance Institute for Highway Safety.

Whiplash is a common, debilitating occurrence in vehicular accidents, most often occurring as a result of rear or side impacts where the occupant's head is thrown backwards and sideways, causing soft tissue damage in the neck or back. Whiplash is extremely painful, and can take months or even years to heal, and sometimes never does. Head restraints can help mitigate the resulting injury, but only if correctly positioned.

A self-contained, motorized head restraint prototype system has been developed, with a customized capacitive sensor array integrated in the front of the device. Using electric field sensing, the array measures the distance between the back of the occupant's head and the front of the restraint, and a 3D time-of-flight camera installed below the rear-view mirror determines the orientation of the occupant's head. This latter information is important, since whiplash severity is greater when the vehicle occupant's head is turned—the restraint needs to be that much closer to limit the injury.

"We can control motors embedded in the head restraint to raise and lower it, and move it forward and backward."

"With the fused sensor data," Ziraknejad says, "we can control motors embedded in the head restraint to raise and lower it, and move it forward and backward." Ongoing research will determine the optimal position for mitigating whiplash injuries, given the occupant's head position and orientation. Appropriate intervals for re-positioning the headrest in the course of normal driving will be determined as well. Knowledge of the driver's head orientation also lends itself to possible driver distraction/fatigue detection applications.

Machine Vision at Your Fingertips

On the residential side, NZTech is part of a six-member industrial consortium led by TELUS that is supporting the ICICS "People and Planet Friendly Home" sustainability initiative (see *Innovations*, Fall/Winter 2012). In this project, 25 researchers from 7 different UBC departments are developing novel integrated technologies for residential spaces that promote both sustainability and quality of life.

In the research strand supported by NZTech, machine vision and cloud computing are being harnessed to assist in cooking and baking. The researchers and NZTech have developed a small, portable device equipped with 3D cameras, a thermometer, and an ARM processor-based embedded system, that attaches to the outside of the window in the oven door. As an item is cooking, it selectively senses for designated states, such as a certain colour, that will indicate that the item is done. This information is correlated with the item's internal temperature determined by a cooking thermometer, and an alert together with live video frames of the food are sent to the resident on a mobile device.

Selective sensing does not capture the entire object of interest, therefore requires less bandwidth to transmit the live images. In addition, less onboard preprocessing is required, reducing power consumption. Additional processing, if necessary, is done on a cloud-based server.

"There is a trade-off," Ziraknejad states. "You might be able to do all of the processing onboard, but at the cost of higher power consumption. By leaving the heavy processing for the cloud, we can also keep the system working in real-time, which is critical."

Real-time, portable machine vision and processing for a variety of tasks in the home is NZTech's ultimate goal for the device, having developed a proof-of-concept prototype for the oven application. The company is now working on a pan-and-tilt mount, so the device can be placed anywhere in the home and targeted as required. They are also investigating the feasibility of wireless power transmission to the device.

"We hope to have a suite of image-processing modules for different applications," Ziraknejad says, "including drug dosage reminders and fall detection. We want to provide machine vision at your fingertips." He means this last point both figuratively and literally. The company is developing a gesture and voice-based interface, associated with a light projector that can project results on any surface. Internet-based information such as weather or traffic patterns could also be requested by a voice command, then projected on a designated surface with a certain gesture.

"We are aiming at an affordable, general platform that can do many things for you," Ziraknejad states. With a working prototype in hand and ICICS research heft behind him, NZ Technologies is well on the way.

**For more information,
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UBC's Institute for Computing, Information and Cognitive Systems (ICICS) is an umbrella organization that promotes collaboration among researchers from the faculties of Applied Science, Arts, Commerce, Education, Forestry, Medicine, and Science, and with industry. ICICS facilitates the collaborative multidisciplinary research of approximately 200 faculty members and 1,000 graduate students in these faculties.

Our members attract approximately $18 million annually in grants and contracts. Their work strengthens Canada's strategic Science and Technology research priority areas, benefiting all Canadians.

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