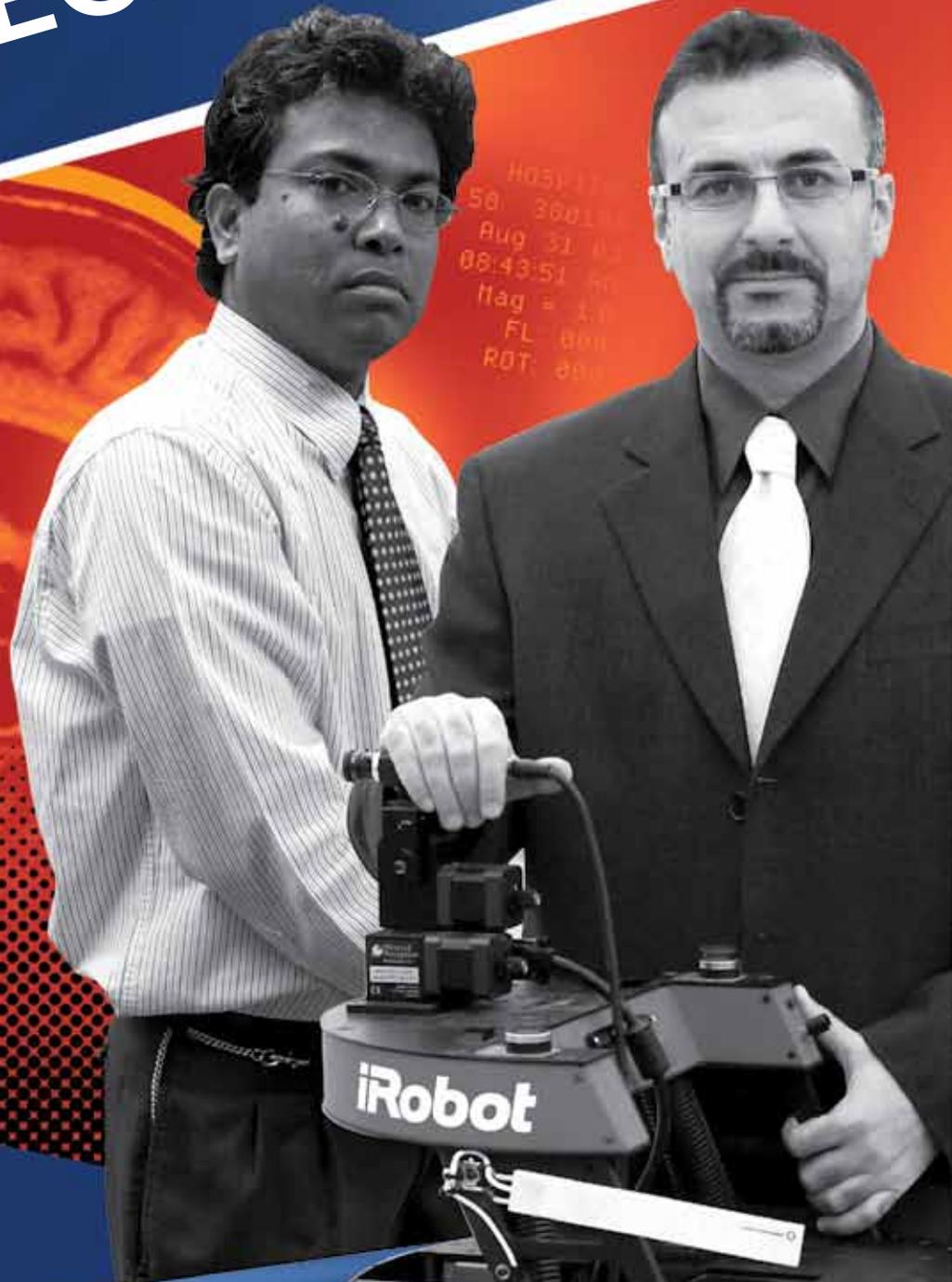
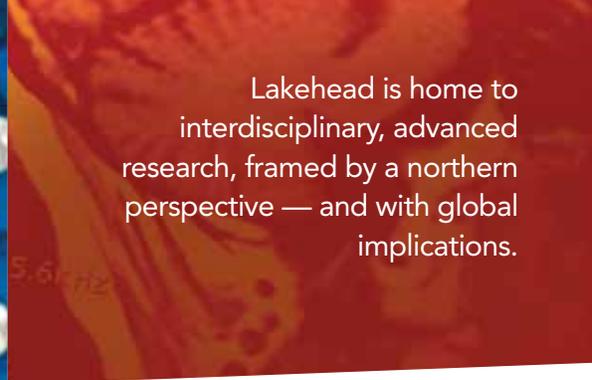


# RESEARCH & INNOVATION ADVANCED TECHNOLOGY





Lakehead is home to interdisciplinary, advanced research, framed by a northern perspective — and with global implications.

# CREATING THE FUTURE NOW

Working in and across Lakehead University's network of more than 30 high-tech labs, our researchers are developing the next generation of specialized technology applications that range from medicine to artificial intelligence to agriculture and information sciences.

At the new Northern Ontario School of Medicine, for example, Dr. Rachel Ellaway is leading an initiative to create a simple, adaptable, and extensible platform for virtual healthcare training and education. Computer scientists Dr. Sabah Mohammed and Dr. Jinan Fiaidhi are applying "cloud" and "cloud" computing technologies to ensure that remote and rural communities have access to the benefits of personalized health data. Dr. Gautam Das, head of Lakehead's Photonics Research Group, is developing increasingly sensitive, robust laser technology for applications in industrial processing, environmental monitoring, biomedicine, and noninvasive diagnosis. Dr. Alla Reznik, Canada Research Chair in the Physics of Molecular Imaging, is using advances in solid-state technology to create better diagnostic tools.

With six graduate programs and a strong commitment to interdisciplinary work and student development, Lakehead offers an ideal environment for graduate students intent on creating the technological applications that will transform our world — for the better.



## LASER **focus**

A laser sensor analyzes the breath of a patient with diabetes, detecting traces of a gas that will help her fine-tune her insulin dosage. In the hospital, doctors use laser-enabled, optical coherence tomography to capture micrometer-resolution, three-dimensional images of human tissues; a few floors up, nanoparticles interact with laser radiation and detect a cancer tumour. Meanwhile, out in the wheat and canola fields, farmers and agribusiness are using sophisticated laser sensors to detect nitrous oxide levels in the air and calibrate exactly when, where, and how much fertilizer to use on their crops.

These are just some of the medical and industrial applications that Dr. Gautam Das, an associate professor in Lakehead's physics department, envisions for his work in the development of fiber lasers.



Fiber lasers, Dr. Das explains, are established, robust, and reliable. Compared to rival technologies, such as gas and semiconductor lasers, they are compact, cost-effective, and portable — not to mention "tunable" to the requirements of different applications — which lends them to a variety of uses.

Already, Dr. Das and his team have been able to detect hydrogen sulfide gas with laser technology. In time, they hope to develop new devices for applications in industrial processing, environmental monitoring, biomedical research, and noninvasive diagnosis.

Dr. Das's work is supported by the Natural Sciences and Engineering Research Council of Canada (NSERC).

**Dr. Gautam Das**  
Department of Physics

# LAKEHEAD UNIVERSITY IS AT THE FOREFRONT OF RESEARCH AND INNOVATION IN THE STEWARDSHIP AND DEVELOPMENT OF OUR ENVIRONMENTAL RESOURCES — LAKEHEAD IS LEADING THE WAY

## NON-ROUTINE maintenance

Change the oil in your car every three months. Change the air filter in your furnace once a year. This kind of regular, scheduled maintenance is just common sense, isn't it?



Maybe not, says Dr. Wilson Wang, an associate professor in Lakehead University's Department of Mechanical Engineering. "In the aerospace industry, for example, airplanes are taken out of service after a fixed number of flight hours to undergo regular inspections," he points out. "Often, the planes remain idle unnecessarily, because no faults are detected." One-third to one-half of the considerable amount of money spent on maintenance in industry, he notes, is wasted through these kinds of inefficiencies.

Dr. Wang's goal is to develop a new generation of intelligent diagnostic and prognostic systems that can more reliably monitor and control the health conditions of machinery, in real time. Such systems would be able to pinpoint faulty components, estimate their potential effects on other components, suggest a schedule for repairs, and forecast the remaining useful life of the damaged unit. What's more, these "smart" systems could analyze data to adapt and improve their own performance.

Supported by the Canada Foundation for Innovation (CFI), Dr. Wang has established LIMS, the Laboratory for Intelligent Mechatronics Systems, at Lakehead, where much of this research will be conducted. Dr. Wang's work is also supported by the Natural Sciences and Engineering Research Council of Canada (NSERC), Materials and Manufacturing Ontario, and industrial partners.

**Dr. Wilson Wang**  
Department of Mechanical Engineering

## BROADENING bandwidth

"During the past two decades, Internet traffic has increased exponentially," says Dr. Hassan Naser, a professor in Lakehead's Department of Software Engineering. "And the growth shows no sign of stopping."

As director of Lakehead's industry-quality Broadband Communications Networks Laboratory, Dr. Naser is researching technologies that will allow local providers to meet our increasing appetites for broadband.

Working with industry partner Tbaytel, Dr. Naser is using Gigabit-Ethernet Passive Optical Network (GPON) technology to create an integrated platform that can deliver high-speed, high-quality, voice, video, and Internet service to business and residential customers. GPON, he explains, has greater capacity and reliability than traditional, copper-wire based networks, and is less expensive.

In a related project, Dr. Naser, with scientists Dr. Samuel Pichardo and Dr. Laura Curiel from the Thunder Bay Regional Research Institute, is designing and developing Radio over Fiber Sensor Network technology to help facilitate MRI-guided medical treatments.



With a background in industry and a substantial research record that includes publications in the *IEEE Journal on Selected Areas in Communications* and the *IEEE/ACM Transactions on Networking*, Dr. Naser brings his considerable experience in the research and development of data and communications networks to his work.

Dr. Naser's research is funded by the Natural Sciences and Engineering Research Council of Canada (NSERC).

**Dr. Hassan Naser**  
Department of Software Engineering



## SIMULATION without frontiers

Picture it: a member of an Arctic exploration team has fallen down an icy crevasse. Her rescue team is in Cork, Ireland. Their base, with access to medical professionals, is in Sudbury, Ontario. A consulting physician in Montreal advises on emergency treatments. The medevac team, responsible for getting the patient out of the chasm and to the hospital, works out of Ottawa, Ontario. From their far-flung locations, the teams must work together to get their patient to safety.

Real life? No. But this kind of simulated training exercise helps prepare real-life medical professionals for the kinds of situations they'll face in the field. For Dr. Rachel Ellaway, whose work concentrates on online learning, simulation, and the use of new technologies for teaching and assessment, it's the future of medical training.

Dr. Ellaway, who is the assistant dean for informatics, acting director of simulation, and an associate professor at the Northern Ontario School of Medicine, is the lead investigator for the Healthcare Services Virtual Organization (HSVO) project, based at Lakehead University.

The project has created a simple, adaptable, and extensible network-enabled platform for healthcare training and education. With HSVO, healthcare professional learners gain access to information, experts, and simulated training opportunities they may not have at their own sites.

Applications for HSVO, says Dr. Ellaway, could range from connecting health teams across the North to international development work, training for emergency medical response teams, military training, or even to hospitals with multiple sites across a large urban area.

HSVO is funded by CANARIE (Canada's Advanced Research and Innovation Network).

**Dr. Rachel Ellaway**  
Faculty of Medicine, Lakehead University  
Northern Ontario School of Medicine

## TOWARDS highly autonomous UAVs

Planes that fly themselves? To some, it's an idea straight out of *The Jetsons*. In fact, however, unmanned aerial vehicles (UAVs) are already being used in a variety of applications, from military operations and rescue missions to filmmaking and understanding more about our climate and pollution.



Dr. Abdelhamid Tayebi, a leader in the field of robotics, works on the design of control systems for robot manipulators and small-scale UAVs commonly known as "drones." His research focuses mainly on developing new theoretical tools enabling the design of efficient feedback control techniques for complex and challenging systems such as UAVs.

"Feedback is a central feature of life," explains Dr. Tayebi, a full professor in the Department of Electrical Engineering at Lakehead University and the founder and director of the University's Automatic Control Laboratory. "It can tell you where you went wrong and affirm what you do right. It can thus help you generate smart actions to improve your future outcomes. Feedback systems are everywhere, from the interaction of proteins in cells, to the interaction of organisms in complex ecologies, and from everyday household appliances to advanced space vehicles."

Dr. Tayebi's research contributes to the advancement of the state of knowledge in modern control theory and aerospace engineering. He hopes that, one day, his research work will lead to highly autonomous, "smart" UAVs that can accomplish complex tasks with a little help from human operators. In other words, planes that fly themselves.

Dr. Tayebi's research is funded by the Natural Sciences and Engineering Research Council of Canada (NSERC) and the Canada Foundation for Innovation (CFI).

**Dr. Abdelhamid Tayebi**  
*Department of Electrical Engineering*

## A HIT FOR RURAL and northern healthcare

It used to be that a Medic-Alert bracelet was just about the only way to provide instant, portable medical information in an emergency.

Today, Internet technology has revolutionized the concept of a personal health record, (PHR): reams of information on an individual's health history, medications, previous hospitalizations, insurance, blood type, and other conditions can be digitally stored in a variety of forms and accessed with a simple password. Unlike electronic health records, maintained by a provider, PHRs are maintained by individual patients and can be customized and accessed by a variety of service providers — even over a patient's mobile phone or PDA. What's more, PHRs can be used at a community health level to detect patterns of disease and potential outbreaks.

All that health information, however, is sensitive stuff. At Lakehead University's Department of Computer Science, Dr. Sabah Mohammed — with graduate student Daniel Servos — is developing safe, secure ways to share sensitive information like PHRs over the Internet, by using a flexible, scalable "cloud computing" infrastructure, which delivers computing services wherever and whenever users need it. His goal is to find ways to provide PHR technology to northern and rural areas, which often lack the health information technology (HIT) infrastructure to securely support it.

Dr. Jinan Fiaidhi, an expert in ubiquitous computing and collaborative learning, and her graduate student Jeff Santarossa, are collaborating with Dr. Mohammed in the area of "calm computing": technological strategies that aim to reduce the "excitement" of information overload by letting users select the most pertinent information and moving unneeded details to the periphery. In an emergency, explain the two researchers, when a cell phone may be the only means of accessing crucial information, PHRs and calm technology may — literally — be lifesavers.

Dr. Mohammed and Dr. Fiaidhi's research is funded by the Natural Sciences and Engineering Research Council of Canada (NSERC).

**Dr. Sabah Mohammed**  
*Department of Computer Science*

**Jinan Fiaidhi**  
*Department of Computer Science*



## GRADUATE PROGRAMS in areas related to advanced technology

### Faculty of Engineering

- MSc Eng (Control Engineering)
- MSc Eng (Electrical and Computer Engineering)
- MSc Eng (Environmental Engineering)

### Faculty of Science and Environmental Studies

- MSc (Computer Science)
- MA and MSc (Mathematical Sciences)
- MSc (Physics)