2018 POLYTECHNIQUE MONTRÉAL WINTER RESEARCH INTERNSHIP

POLYTECHNIQUE MONTRÉAL

WORLD-CLASS ENGINEERING

Founded in 1873, **Polytechnique Montréal** is a leading Canadian university for the scope and intensity of its engineering research and industrial partnerships. It is ranked #1 for the number of Canada Research Chairs in Engineering, the most prestigious research funding in the country, and is also first in Québec for the size of its student body and the scope of its research activities. Polytechnique Montréal has laboratories at the cutting edge of technology thanks to funding of nearly a quarter of a billion dollars from the Canada Foundation for Innovation over the past 10 years. In 2017, Montreal ranked *1st for best student cities!*

Research Internship Program

A research internship is a research activity that is an integral part of a visiting student's academic program at the home institution. Each year, Polytechnique's research units welcome more than 250 students from other universities wishing to put into practice the technical and scientific knowledge acquired in their studies. The research conducted is supervised by a professor of Polytechnique and is always related to needs expressed by society or companies, and can be made in laboratories or *in situ*.

Duration

The recommended duration of the internship is a minimum of 4 months, usually taking place between January and May 2018. Other duration or period can be negotiated to suit your university schedule.

Financial Arrangement

- Tuition fee waiver for the duration of the internship;
- Free transportation from the airport to your place of residence upon your arrival;
- Employer Compliance Fee of $230 CAD covered by Polytechnique Montréal (once the internship is confirmed, the work permit applicant must pay the requested immigration fee).

Outstanding candidates may receive one of the 15 scholarships available! Amount of the scholarship: $1000 CAD per month for a maximum of 4 months.

Eligibility Criteria

- Being enrolled in one of Polytechnique Montréal's partner universities;
- Having completed at least two years of an engineering undergraduate program or at least one year of a graduate program (Master or Ph.D.) according to projects' requirements as described in the following pages;
- Meet the specific skills required by the supervisor if any;
- Being fluent in French or in English (no language proficiency test is required).

Required Documents for Application

(in French or in English)

- Application Form;
- Letter of motivation including the following information (if you have selected 2 research projects, provide a letter of motivation for each project):
  - explanations of your interest in working in the selected project
  - your skills in respect to the project
- Curriculum vitae (CV);
- Copy of your most recent academic transcript;
- Proof of a full-time enrollment from your home institution (the letter must confirm that you are currently enrolled in a full-time program and will continue to be enrolled upon your return);
- If possible, a copy of an internship report made in the past.

To enhance your chances to be selected, choose 2 research projects. It can be 2 research projects from the list or 1 research project from the list and 1 supervisor from the Directory of Expertise!

Application Deadline

All documents must be sent electronically by **July 25, 2017** to the International Relations Office of Polytechnique Montréal: *brin@polymtl.ca*. Please specify in the subject "2018 Winter Research Internship Program". Note that a conference call via Skype may be organized if needed for final selection.

Announcement

The results will be announced in September 2017 to each candidate. Selected candidates will receive an "Offer of Employment to a Foreign National Exempt from a Labour Market Impact Assessment (LMIA)" and will have to apply for a Work Permit at the Canadian Visa office that serves the area they live in.

For any questions regarding your application, please contact:
International Relations Office ■ *brin@polymtl.ca*

2018 POLYTECHNIQUE MONTRÉAL WINTER RESEARCH INTERNSHIP

LIST OF RESEARCH PROJECTS

Click on numbers to access project description

2018 POLYTECHNIQUE MONTRÉAL WINTER RESEARCH INTERNSHIP

ADDITIONAL AREAS OF EXPERTISE

You didn't find what you were looking for?

- Browse our professors' directory by area of expertise: ***www.polymtl.ca/recherche/rc/en/expertises.***
- Submit the area of expertise you would like to work on and provide the names of 2-3 professors working in this field.
- Explain in your letter of motivation why you would like to do a research internship in this area.
- The International Relations Office will try to find the appropriate match for you!

Here are some ideas:

- Aerospace Engineering
- Applied Mathematics
- Artificial Intelligence
- Biomedical Engineering
- Chemical Engineering
- Civil Engineering
- Computer and Software Engineering
- Design and Manufacturing
- Electric and Electronic Engineering
- Environmental Engineering
- Fluid Mechanics
- Fuel and Energy Technology
- Hydrology
- Industrial Engineering
- Information Technology
- Materials Science and Technology
- Mechanical Engineering
- Mining and Mineral Processing
- Nuclear Engineering
- Physics Engineering
- Robotics
- Structural Engineering

#1: Area of Expertise: Aerospace Engineering

Research Project Title

Emitter Array for a Nanosatellite Ion Thruster

University Cycle

1st cycle (undergraduate), 2nd cycle (Master) or 3rd cycle (Ph.D.)

Background Information

The objective of this internship is to contribute to the fabrication of an ion thruster for a Nanosatellite. With technology advancement in the aerospace engineering, space exploration has become accessible for organizations of smaller size, allowing them to contribute to new research on space. Nanosatellites are an affordable option for space exploration, since they require small and cheap launch vehicles. Their propulsion of can be achieved via ion thrusters, an interesting alternative to chemical propulsion. The thruster provides variation of speed during the deceleration for deorbiting, or acceleration to maintain or increase the orbital distance.

In the ion thruster, an ionic liquid (a molten salt at room temperature) is stored in a tank, from where it flows by capillarity to the tip of emitters of a porous metal array. Successively, the ion droplets are accelerated by an electric field generated by a potential difference of 1000V. They will then be ejected through a stainless steel grid, and this force will then propel the satellite.

Electrospray microthruster arrays will be assembled using a microfabrication procedure. A layer of positive-tone photoresist will be spin coated on a Si wafer. After exposure to ultraviolet light through a designed photomask, the wafer will be immersed in a developer, where the exposed photoresist will be removed. At this point, deep reactive ion etching (DRIE) will be performed on the wafer to etch a trench of about 400 microns in depth. After passivation, a thermal oxidation will be carried out on the wafer. Finally, after dicing, the array will be bonded to a glass wafer via anodic bonder and the propellant will be fed via a micro needle. Propulsion tests will be performed via a magnetically levitated balance.

Main Tasks during the Internship

The intern will perform microfabrication of the thruster and will participate to the satellite fabrication, in collaboration with a multidisciplinary team and with the technical society Polyorbite.

Required Skills for the Internship

A background in chemistry, physics or chemical engineering is desirable but not essential.

Location

Bombardier Building

Supervisor

Mr Fabio CICOIRA, Assistant Professor, Department of Chemical Engineering
http://www.polymtl.ca/recherche/rc/en/professeurs/details.php?NoProf=510&Langue=A

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#2: Area of Expertise: Biomedical Engineering

Research Project Title
Twinsting Wire Actuation in Adaptive Robotic Fingers

University Cycle
1st cycle (undergraduate), 2nd cycle (Master) or 3rd cycle (Ph.D.)

Background Information
Mechatronic fingers and hands are used in a wide range of applications, ranging from spatial teleoperation to medical devices. These hands are made of multiple systems, including the actuation, the transmission, the control scheme, and the sensors. To enhance these electromechanical systems and to simplify grasping and manipulation, underactuated mechanisms have been used in the recent years. With a minimized number of actuators and some compliant elements, an underactuated hand is capable of mechanically self-adapting itself to numerous objects during grasping without any complex control law. Thus, a low-cost versatile artificial hand can be designed and manufactured. To provide actuation, DC motors, cables and pulleys are commonly used. However, a new trend in robotics consists of twisting wire actuators. Instead of having a single cable winding around a pulley, at least two wires are twist around each other, modifying their overall length. This can be advantageous in terms of space, transmission and efficiency. The objective of this internship is to assess the possibility of using twisting wire actuation in existing and future underactuated robotic fingers. The intern will have to mathematically model the relationship between the twisted wires length and the torque/position produced by the actuator based on a literature review. He/she will then have to design and build a small scale demonstrator of a robotic finger actuated by the twisting wire actuation mechanism proposed.

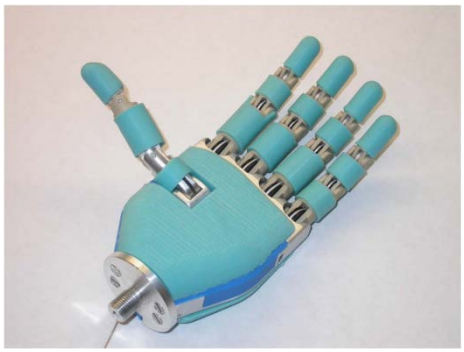

Figure 1: Example of a prostethic hand [Baril, M. *et al*. 2012, *On the design of mechanically programmable underactuated anthropomorphic robotic and prosthetic grippers*, Proc. of ASME Mechanisms and Robotics Conference, Chicago, USA, August, DETC2012-70705.]

Main Tasks during the Internship
The main objective is to model, design and manufacture an actuation mechanism for self-adaptive robotics hands. The intern will have to:

- Modeling of the twisting wire actuator;
- Numerical simulations of the system;
- Design and manufacture a demonstrator;
- Assemble the parts of the prototype and test it.

Required Skills for the Internship

- Good skills in computer-assisted design (CAD), CATIA or Inventor preferably
- Excellent mathematical skills
- Comfortable with machine design and statics
- Prior experience in robotics and mechatronics;
- Excellent writing and speaking communication are mandatory

Location
Main Building

Supervisor
Mr Lionel BIRGLEN, Associate Professor, Department of Mechanical Engineering
http://www.polymtl.ca/recherche/rc/en/professeurs/details.php?NoProf=341&Langue=A

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#3: Area of Expertise: Biomechanical Engineering

Research Project Title
Design and Fabrication of an Orthosis Prototype

University Cycle
1st cycle (undergraduate), 2nd cycle (Master) or 3rd cycle (Ph.D.)

Background Information
Various conditions, such as hemiparalysis, can affect walking gait due to muscular weakness or impaired motor control. The correction and prevention of gait anomalies is typically done using active (i.e. actuated) mechanisms, such as orthoses, rehabilitation devices, or exoskeletons.

A new research direction is currently explored at the robotics laboratory of Polytechnique Montréal to devise a passive device linking the rotations in the sagittal plane of the leg joints. Indeed, the hip, knee and ankle joints all perform periodic motions during a normal step. Conceptually, a mechanism exerting torques proportional to the joint deviations from the prescribed values at the current phase would act as a general-purpose wearable rehabilitation tool.

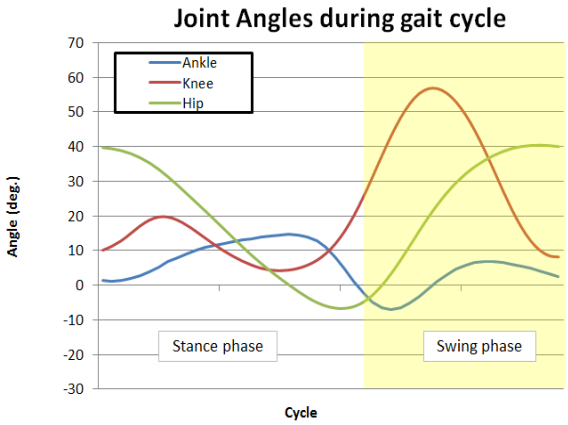

Figure 2: Walking gait cycle

(source : CGA Normative Gait Database, data from Stansfield BW)

Main Tasks during the Internship
In collaboration with the graduate student leading the project, it is required to design and build an engineering prototype implementing the developed mechanism for concept validation and performance analysis purpose. At this stage, the main issue is linking the different body joints to generate the functions illustrated in Fig. 1, for which purpose a test bench simulating either healthy or abnormal gaits is currently developed.

- Model the mechanism according to the existing design parameters.
- Provide the drawings for the manufacturing of the components of the prototype.
- Manufacture and assemble the parts of the prototype.
- Test and document the prototype performance using the existent test bench.

Required Skills for the Internship
Experience with the following techniques is desirable:

- 3D modeling and design
- Rapid prototyping (3D printing & laser cutting)
- Electronic circuit design
- Basic programming skills
- Excellent writing and speaking communication are mandatory

Location
Main Building

Supervisor
Mr Lionel BIRGLEN, Associate Professor, Department of Mechanical Engineering
http://www.polymtl.ca/recherche/rc/en/professeurs/details.php?NoProf=341&Langue=A

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#4: Area of Expertise: Biomedical Engineering

Research Project Title
Design and Fabrication of a Legged Robot Prototype: Phase II

University Cycle
1st cycle (undergraduate), 2nd cycle (Master) or 3rd cycle (Ph.D.)

Background Information
Following the testing of a first series of prototypes demonstrating the self-adaptive behavior of a single underactuated mechanical leg designed at Polytechnique Montréal, the next phase of the project is the design of a multi-legged prototype to compare its performance to traditional walking mechanisms.

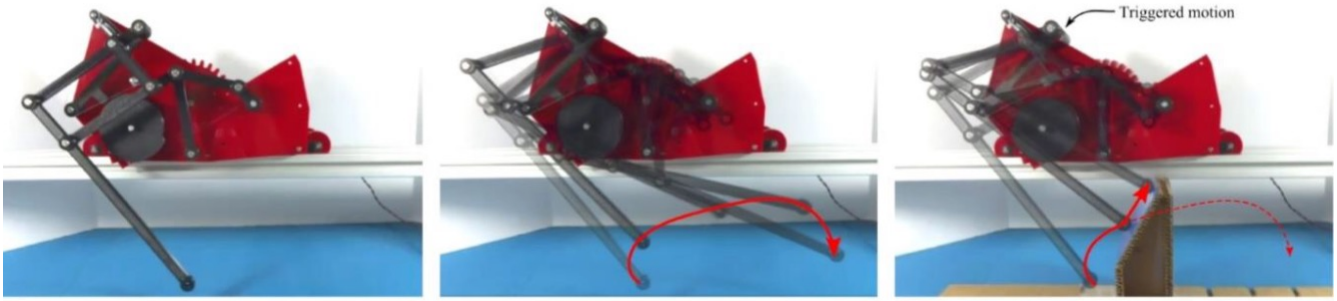
Self-adaptive mechanisms aim at simplifying the control scheme for a given mechanical system by reducing the number of actuators needed to perform variable tasks, and have been used mainly for grasping applications in the past. Typically, a transmission mechanism is used to link the actuated input to several output degrees of freedom, which are constrained using passive elements such as springs

In the proposed mechanism, a passive degree of freedom is triggered if contact with an obstacle occurs during the swing phase, which allows the leg to depart from its initial trajectory and slide along the obstacle.

This approach is different from that of a fully actuated robotic leg mimicking a human or animal gait, and aims to provide good traversability using a single actuator with constant input velocity. While encouraging results have been obtained for a single leg prototype, further experimentation with multiple underactuated legs driven by a common actuator is planned.

Additional references:
FEDOROV, Dmitri, and BIRGLEN, Lionel. "Design of a Self-Adaptive Robotic Leg Using a Triggered Compliant Element." IEEE Robotics and Automation Letters 2.3 (2017): 1444-1451.

Video demonstrating the current prototype: https://www.youtube.com/watch?v=2zo5aSJEjhY&t=11s



(a) Initial position (b) Freespace trajectory (c) Trajectory with obstacle

Main Tasks during the Internship
In collaboration with the graduate student leading the project, it is required to design and build a prototype of a multi-legged robot implementing the developed leg mechanism for validation and performance analysis purposes.

Mechanical designing, manufacturing, and testing a prototype of an underactuated legged robot:
- Model the robot according to the existing design parameters;
- Provide the drawings for the manufacturing of the components of the prototype;
- Assemble and test the parts of the prototype (obtained by 3D printing & laser cutting)
- Proceed with performance and traversability experiments.

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Required Skills for the Internship
Experience with the following techniques is desirable:

- 3D modeling and design (SolidWorks / Catia)
- Rapid prototyping (3D printing & laser cutting)
- Basic programming skills (Experience with Matlab is useful)
- Excellent writing and speaking communication are mandatory

Location
Main Building

Supervisor
Mr Lionel BIRGLEN, Associate Professor, Department of Mechanical Engineering
http://www.polymtl.ca/recherche/rc/en/professeurs/details.php?NoProf=341&Langue=A

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#5: Area of Expertise: Biomedical Engineering

Research Project Title
Neuroimaging with MRI: Data Analysis and Application in Patients

University Cycle
1st cycle (undergraduate), 2nd cycle (Master) or 3rd cycle (Ph.D.)

Background Information
The NeuroPoly lab is developing advanced methods for magnetic resonance imaging (MRI). Our environment is highly multi-disciplinary: you will interact with physicists, engineers, radiologists and neurologists. More information about our research projects can be found here: www.neuro.polymtl.ca.

Main Tasks during the Internship
Projects involve methodological developments such as hardware (antennas), image processing (segmentation, motion correction, multimodal registration) and clinical applications (multiple sclerosis, spinal cord injury).

Required Skills for the Internship
- Programming (Python, Matlab, C/C++).
- Physics, mathematics
- Image analysis
- Experience in machine learning (deep learning) is an asset

Location
Lassonde Building

Supervisor
Mr Julien COHEN-ADAD, Assistant Professor, Institute of Biomedical Engineering, Department of Electrical Engineering
http://www.polymtl.ca/recherche/rc/en/professeurs/details.php?NoProf=547&Langue=A

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#6: Area of Expertise: Chemical Engineering

Research Project Title
Conducting Polymer Coating of Neural Electrodes

University Cycle
1st cycle (undergraduate), 2nd cycle (Master) or 3rd cycle (Ph.D.)

Background Information
Organic electronics, based on semiconducting and conducting polymers, have found commercial applications in lighting panels, smartphone screens, and TV screens using OLEDs (organic light emitting diodes) technology. Organic electronic devices, apart from consumer applications, are paving the path for key applications at the interface of electronics and biology, such as in electrodes for recording and stimulating neural activity. In such applications, organic polymers are very attractive candidates due to their distinct property of mixed conduction: the ability to transport both electron/holes and ionic species. The ionic conduction is of special importance since most biological signals consist of ionic currents.

The main objectives of this internship is to fabricate novel deep brain electrodes by electrochemical polymerization. The fabrication of the electrode will be performed by electrochemical polymerization of ethylenedioxythiophene (EDOT) on sharp metal probes in different electrolytes, which will result in poly ethylenedioxythiophene (EDOT) films. The films will be then characterized by Electrochemical Impedance Spectroscopy (EIS) to assess which film morphology and chemical composition lead to the lowest internal transport impedance. High-resolution measurements of ionic fluxes between the polymer channel and the electrolyte to evaluate the ability of the OECT devices to deliver biologically active substances will be performed by SICM. The optimization and final design of devices are expected to emerge from experimenting with various thin-film processing methods of conducting polymers. The in vivo experiment protocols and details are expected to be developed in collaboration with neuroscientists at Montreal and Laval Universities.

Main Tasks during the Internship
The student will perform electrochemical polymerization as well as of electrochemical measurements (electrochemical impedance spectroscopy, cyclic voltammeter, scanning ion conductance microscopy). If electrodes will be successfully prepared, she/he could be also involved in in-vivo testing on animals.

Required Skills for the Internship
A motivation to work in a multidisciplinary team, at the interface between biology and materials science, is highly required.

Location
Bombardier Building of Polytechnique Montréal and Desmarais Building of Université de Montréal

Supervisor
Mr Fabio CICOIRA, Assistant Professor, Department of Chemical Engineering
http://www.polymtl.ca/recherche/rc/en/professeurs/details.php?NoProf=510&Langue=A

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#7: Area of Expertise: Chemical Engineering

Research Project Title
Self-Healing Conducting Polymers

University Cycle
1st cycle (undergraduate), 2nd cycle (Master) or 3rd cycle (Ph.D.)

Background Information
Self-healing materials possess the ability to repair a mechanical damage. The demand of self-healing materials is increasing especially in electronics, automotive and aerospace as well as in biomimetics, artificial skin and soft robotics. For applications requiring the self-healing materials to be electrically conductive, a major challenge is to match high conductivity, fast and repeatable self-healing at room temperature with facile processing, in a single material.

In this research internship we will explore the self-healing properties of conducting polymer films. Self-healing materials entirely based on conducting polymers will constitute a significant advantage towards present self-healing materials, which are mostly based on complex multi component systems.

We will deposit films of self-healing materials by spin coating and vapour phase polymerization. We will study the self-healing properties of films included between two metal electrodes. A voltage will be applied between the two electrodes to permit a current flow in the films. The films will be successively cut with a sharp object. The damage will likely interrupt the current flow. If the material is self-healable, the current is expected to recover after a certain time. Besides autonomous healing, we will also investigate healing assisted by aqueous solutions. This will be achieved by monitoring the current flowing in the film after damaging and exposing the damaged directly to the fluids. The healing effect will be monitored in situ with an optical microscope. To shed light into the self-healing mechanism, ex situ characterization of the morphology and the chemical composition of the damaged area will be carried out with X-ray photoelectron spectroscopy (XPS) and Scanning Electrochemical Microscopy.

Main Tasks during the Internship
The student will perform processing of self-healing materials from conducting polymer suspensions and additives, as well as damage/healing experiments on the films and electromechanical characterization. With the supervision of a PhD student, she/he will participate to scanning electrochemical microscopy measurements.

Required Skills for the Internship
A background in chemistry, physics or chemical engineering is desirable but not essential.

Location
Bombardier Building

Supervisor
Mr Fabio CICOIRA, Assistant Professor, Department of Chemical Engineering
http://www.polymtl.ca/recherche/rc/en/professeurs/details.php?NoProf=510&Langue=A

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#8: Area of Expertise: Chemical Engineering

Research Project Title

Natural Gas Flaring Reduction Initiative: Catalytic Partial Xxidation of Syngas over Advance Material Supports at High Pressure (FeCrAlloy)

University Cycle

2nd cycle (Master) or 3rd cycle (Ph.D.)

Background Information

Methane, ethane, and nitrogen and sulphur compounds come out of solution when oil is pumped to the surface from high pressure reservoirs. These gases are flared (or vented), which harms the environment, because it is uneconomic to treat the gas. The PhD project will examine technologies to convert this wasted natural gas to value-added fuels or chemicals. The key aspect of the process is to design economic micro-refinery technology that can be implemented in remote regions of the world so that the diesel type hydrocarbons and chemicals will be useful for local populations. It integrates multiple heterogeneous catalytic reactions in a single vessel and seek economies through mass manufacturing-numbering up- rather than scale-up.

Main Tasks during the Internship

- Operating reactors
- Analysing gas phase and liquid phase reaction products via GC and MS.
- Reactor modelling

Required Skills for the Internship

Familiar with experimental protocols, operating analysers, synthesizing catalysts.

Location

Main Building

Supervisor

Mr Gregory PATIENCE, Professor, Department of Chemical Engineering
http://www.polymtl.ca/recherche/rc/en/professeurs/details.php?NoProf=305

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#9: Area of Expertise: Chemical Engineering

Research Project Title
Glucose Catalytic Selective Oxydehydrogenation to Specialty Chemicals

University Cycle
2nd cycle (Master) or 3rd cycle (Ph.D.)

Background Information
Glucose, fructose and xylose are sugars derived from biomass. Rather than fermenting them to ethanol for a fuel additive, we patented a process to keep the functionality of the oxygen and produce specialty chemicals and monomers. The value of alcohol is 600 $/t while the specialty monomers are worth 2400 $/t. We have licensed the technology and are working with a start-up company to commercialize the process but we are also developing new chemistry: hydrogenation, esterification, hydrocracking, etc.

We work in micro-fluidized bed reactors but have larger fluidized beds to test hydrodynamics. The candidate will synthesize catalysts to test these new chemistries in a small fluidized bed reactor (400 g). During the course of the PhD, we expect to publish papers in high IF journals and patent the technology and develop basic data to design pilot plants.
At the end of the PhD, the candidates will develop skills in catalysis, reaction engineering, kinetic modelling, fluidization and numerical modelling. Candidates will be capable of building experimental equipment, running experiments and capable of developing an experimental design.

Main Tasks during the Internship
- Operate fluidized bed reactors, analyse liquid and gas streams with GC and MS.
- Reactor modelling

Required Skills for the Internship
Chemical engineering, familiarity with catalysis, modelling and experimental methods related to gas-solids fluidization.

Location
Main Building

Supervisor
Mr Gregory PATIENCE, Professor, Department of Chemical Engineering
http://www.polymtl.ca/recherche/rc/en/professeurs/details.php?NoProf=305

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#10: Area of Expertise: Chemical Engineering

Research Project Title

Evaluation of Clean Technologies for the Forest Bioeconoomy: Cellulose Nano Crystals (CNC)

University Cycle

1st cycle (undergraduate), 2nd cycle (Master) or 3rd cycle (Ph.D.)

Background Information

Product and Process Design of the Forest Biorefinery: In our research laboratory at Polytechnique-Montréal, we use product and process design and systems analysis tools to address real-world challenges for the development of the bioeconomy. Be part of a more sustainable future! You will be integrated into our research team on product and process design, focusing on integrating forest biorefinery technologies into the forest products sector. You will be part of a team of interns applying a similar methodology, but for different clean technologies. You will have the opportunity to exchange with graduate students and other experts in the domain, that have business and technology experience with large international companies. Specifically, the objective of this internship is to conduct a systematic evaluation of leading clean technologies for the production of Cellulose Nano Crystals (CNC).

Main Tasks during the Internship

You will be required to systematically address the following scope of work:

- Review the technology landscape, i.e. main technology providers and main producers
- For each technology provider/producer:
    - Define the technology principal of operation
    - Describe the technology
    - Evaluate the technology maturity, eg Technology Readiness Level (TRL), and the key characteristics of the existing production facilities
- Analyze the advancement of the company in terms of product development, market understanding and strategic partnerships
- Identify the main technology risks, and whether you believe these will be successfully addressed
- Identify the main technology advantages compared to competing technologies
- Complete a critical analysis, for example in the form of a SWOT (Strengths Weaknesses Opportunities and Threats)

The work will be done based on the pre-existing body of knowledge, publically-available information, as well as complementary research and critical analysis. Interns will work primarily in PowerPoint using a structure that follows the one of the final report, and be required to make weekly presentations. During the final month of the internship, a final report must be written following a template Table of Contents.

Required Skills for the Internship

- Interest in sustainability, bioeconomy, clean technologies
- Team-based work
- Good communication and presentation skills - essential
- Strong analytical skills and systematic approach in conducting research - essential
- Chemical or Industrial Engineers - preferred, but not essential
- At least one course in process design - preferred, but not essential
- Experience evaluating new technologies - preferred, but not essential

Location

André-Aisenstadt Building

Supervisor

Mr Paul STUART, Professor, Department of Chemical Engineering
Fellow – Canadian Academic of Engineering (CAE)
Fellow-Pulp and Paper Technical Association of Canada (PAPTAC)
http://www.polymtl.ca/recherche/rc/en/professeurs/details.php?NoProf=249&Langue=A

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#11: Area of Expertise: Chemical Engineering

Research Project Title

Critical Assessment of Clean Technologies for the Forest Bioeconomy: Micro-Fibrillated Cellulose (MFC)

University Cycle

1st cycle (undergraduate), 2nd cycle (Master) or 3rd cycle (Ph.D.)

Background Information

In our research laboratory at Polytechnique-Montréal, we use product and process design and systems analysis tools to address real-world challenges for the development of the bioeconomy. Be part of a more sustainable future! You will be integrated into our research team on product and process design, focusing on integrating forest biorefinery technologies into the forest products sector. You will be part of a team of interns applying a similar methodology, but for different clean technologies. You will have the opportunity to exchange with graduate students, and other experts in the domain that have business and technology experience with large international companies. Specifically, the objective of this internship is to conduct a systematic evaluation of leading clean technologies for the production of Micro-Fibrillated Cellulose (MFC). We are developing a technologies database for the production of leading biomaterials in the emerging bioeconomy. You will be requested to develop technology insights, and conduct a critical review of available information in order to identify the strengths and weaknesses of leading clean technologies.

Main Tasks during the Internship

You will be required to systematically address the following scope of work:

- Review the technology landscape, and identify the leading and emerging technology providers and main bioproduct manufacturers in the marketplace
    - Identify the company history, eg spin-off, merger, etc
    - Identify company analytics on size, revenues etc where available
    - Evaluate the company management
- For each technology provider/producer:
    - Define the technology principal of operation
    - Describe the technology
    - Evaluate the technology maturity, eg Technology Readiness Level (TRL), and the key characteristics of the existing production facilities
- Analyze the advancement of the company in terms of product development, market understanding and strategic partnerships
- Identify the main technology risks, and whether you believe these will be successfully addressed
- Identify the main technology advantages compared to competing technologies
- Complete a critical analysis, for example in the form of a SWOT (Strengths Weaknesses Opportunities and Threats)

The work will be done based on the pre-existing body of knowledge, publically-available information, as well as complementary research and critical analysis.Interns will work primarily in PowerPoint using a structure that follows the one of the final report, and be required to make weekly presentations. During the final month of the internship, a final report must be written following a template Table of Contents.

Required Skills for the Internship

- Interest in sustainability, bioeconomy, clean technologies
- Team-based work
- Good communication and presentation skills - essential
- Strong analytical skills and systematic approach in conducting research - essential
- Chemical or Industrial Engineers - preferred, but not essential
- At least one course in process design - preferred, but not essential
- Experience evaluating new technologies - preferred, but not essential

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Location
André-Aisenstadt Building

Supervisor
Mr Paul STUART, Professor, Department of Chemical Engineering
Fellow – Canadian Academic of Engineering (CAE)
Fellow-Pulp and Paper Technical Association of Canada (PAPTAC)
http://www.polymtl.ca/recherche/rc/en/professeurs/details.php?NoProf=249&Langue=A

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#12: Area of Expertise: Chemical Engineering

Research Project Title

Critical Assessment of Clean Technologies for the Forest Bioeconomy: Precipitated Lignin from the Kraft Pulping Process

University Cycle

1st cycle (undergraduate), 2nd cycle (Master) or 3rd cycle (Ph.D.)

Background Information

In our research laboratory at Polytechnique-Montréal, we use product and process design and systems analysis tools to address real-world challenges for the development of the bioeconomy. Be part of a more sustainable future! You will be integrated into our research team on product and process design, focusing on integrating forest biorefinery technologies into the forest products sector. You will be part of a team of interns applying a similar methodology, but for different clean technologies. You will have the opportunity to exchange with graduate students, and other experts in the domain that have business and technology experience with large international companies. Specifically, the objective of this internship is to conduct a systematic evaluation of leading clean technologies for the production of Precipitated Lignin from the Kraft Pulping Process. We are developing a technologies database for the production of leading biomaterials in the emerging bioeconomy. You will be requested to develop technology insights, and conduct a critical review of available information in order to identify the strengths and weaknesses of leading clean technologies.

Main Tasks during the Internship

You will be required to systematically address the following scope of work:

- Review the technology landscape, and identify the leading and emerging technology providers and main bioproduct manufacturers in the marketplace
    - Identify the company history, eg spin-off, merger, etc
    - Identify company analytics on size, revenues etc where available
    - Evaluate the company management
- For each technology provider/producer:
    - Define the technology principal of operation
    - Describe the technology
    - Evaluate the technology maturity, eg Technology Readiness Level (TRL), and the key characteristics of the existing production facilities
- Analyze the advancement of the company in terms of product development, market understanding and strategic partnerships
- Identify the main technology risks, and whether you believe these will be successfully addressed
- Identify the main technology advantages compared to competing technologies
- Complete a critical analysis, for example in the form of a SWOT (Strengths Weaknesses Opportunities and Threats)

The work will be done based on the pre-existing body of knowledge, publically-available information, as well as complementary research and critical analysis. Interns will work primarily in PowerPoint using a structure that follows the one of the final report, and be required to make weekly presentations. During the final month of the internship, a final report must be written following a template Table of Contents

Required Skills for the Internship

- Interest in sustainability, bioeconomy, clean technologies
- Team-based work
- Good communication and presentation skills - essential
- Strong analytical skills and systematic approach in conducting research - essential
- Chemical or Industrial Engineers - preferred, but not essential
- At least one course in process design - preferred, but not essential
- Experience evaluating new technologies - preferred, but not essential

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Location
André-Aisenstadt Building

Supervisor
Mr Paul STUART, Professor, Department of Chemical Engineering
Fellow – Canadian Academic of Engineering (CAE)
Fellow-Pulp and Paper Technical Association of Canada (PAPTAC)
http://www.polymtl.ca/recherche/rc/en/professeurs/details.php?NoProf=249&Langue=A

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#13: Area of Expertise: Chemical Engineering

Research Project Title

Critical Assessment of Clean Technologies for the Forest Bioeconomy: Pyrolysis Oil

University Cycle

1st cycle (undergraduate), 2nd cycle (Master) or 3rd cycle (Ph.D.)

Background Information

In our research laboratory at Polytechnique-Montréal, we use product and process design and systems analysis tools to address real-world challenges for the development of the bioeconomy. Be part of a more sustainable future! You will be integrated into our research team on product and process design, focusing on integrating forest biorefinery technologies into the forest products sector. You will be part of a team of interns applying a similar methodology, but for different clean technologies. You will have the opportunity to exchange with graduate students, and other experts in the domain that have business and technology experience with large international companies. Specifically, the objective of this internship is to conduct a systematic evaluation of leading clean technologies for the production of Pyrolysis Oil. We are developing a technologies database for the production of leading biomaterials in the emerging bioeconomy. You will be requested to develop technology insights, and conduct a critical review of available information in order to identify the strengths and weaknesses of leading clean technologies.

Main Tasks during the Internship

You will be required to systematically address the following scope of work:

- Review the technology landscape, and identify the leading and emerging technology providers and main bioproduct manufacturers in the marketplace
    - Identify the company history, eg spin-off, merger, etc
    - Identify company analytics on size, revenues etc where available
    - Evaluate the company management
- For each technology provider/producer:
    - Define the technology principal of operation
    - Describe the technology
    - Evaluate the technology maturity, eg Technology Readiness Level (TRL), and the key characteristics of the existing production facilities
- Analyze the advancement of the company in terms of product development, market understanding and strategic partnerships
- Identify the main technology risks, and whether you believe these will be successfully addressed
- Identify the main technology advantages compared to competing technologies
- Complete a critical analysis, for example in the form of a SWOT (Strengths Weaknesses Opportunities and Threats)

The work will be done based on the pre-existing body of knowledge, publically-available information, as well as complementary research and critical analysis. Interns will work primarily in PowerPoint using a structure that follows the one of the final report, and be required to make weekly presentations. During the final month of the internship, a final report must be written following a template Table of Contents.

Required Skills for the Internship

- Interest in sustainability, bioeconomy, clean technologies
- Team-based work
- Good communication and presentation skills - essential
- Strong analytical skills and systematic approach in conducting research - essential
- Chemical or Industrial Engineers - preferred, but not essential
- At least one course in process design - preferred, but not essential
- Experience evaluating new technologies - preferred, but not essential

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Location
André-Aisenstadt Building

Supervisor
Mr Paul STUART, Professor, Department of Chemical Engineering
Fellow – Canadian Academic of Engineering (CAE)
Fellow-Pulp and Paper Technical Association of Canada (PAPTAC)
http://www.polymtl.ca/recherche/rc/en/professeurs/details.php?NoProf=249&Langue=A

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#14: Area of Expertise: Chemical Engineering

Research Project Title

Critical Assessment of Clean Technologies for the Forest Bioeconomy: Hydrothermal Treatment

University Cycle

1st cycle (undergraduate), 2nd cycle (Master) or 3rd cycle (Ph.D.)

Background Information

In our research laboratory at Polytechnique-Montréal, we use product and process design and systems analysis tools to address real-world challenges for the development of the bioeconomy. Be part of a more sustainable future! You will be integrated into our research team on product and process design, focusing on integrating forest biorefinery technologies into the forest products sector. You will be part of a team of interns applying a similar methodology, but for different clean technologies. You will have the opportunity to exchange with graduate students, and other experts in the domain that have business and technology experience with large international companies. Specifically, the objective of this internship is to conduct a systematic evaluation of leading clean technologies for the production of Hydrothermal Treatment. We are developing a technologies database for the production of leading biomaterials in the emerging bioeconomy. You will be requested to develop technology insights, and conduct a critical review of available information in order to identify the strengths and weaknesses of leading clean technologies.

Main Tasks during the Internship

You will be required to systematically address the following scope of work:

- Review the technology landscape, and identify the leading and emerging technology providers and main bioproduct manufacturers in the marketplace
    - Identify the company history, eg spin-off, merger, etc
    - Identify company analytics on size, revenues etc where available
    - Evaluate the company management
- For each technology provider/producer:
    - Define the technology principal of operation
    - Describe the technology
    - Evaluate the technology maturity, eg Technology Readiness Level (TRL), and the key characteristics of the existing production facilities
- Analyze the advancement of the company in terms of product development, market understanding and strategic partnerships
- Identify the main technology risks, and whether you believe these will be successfully addressed
- Identify the main technology advantages compared to competing technologies
- Complete a critical analysis, for example in the form of a SWOT (Strengths Weaknesses Opportunities and Threats)

The work will be done based on the pre-existing body of knowledge, publically-available information, as well as complementary research and critical analysis. Interns will work primarily in PowerPoint using a structure that follows the one of the final report, and be required to make weekly presentations. During the final month of the internship, a final report must be written following a template Table of Contents.

Required Skills for the Internship

- Interest in sustainability, bioeconomy, clean technologies
- Team-based work
- Good communication and presentation skills - essential
- Strong analytical skills and systematic approach in conducting research - essential
- Chemical or Industrial Engineers - preferred, but not essential
- At least one course in process design - preferred, but not essential
- Experience evaluating new technologies - preferred, but not essential

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Location
André-Aisenstadt Building

Supervisor
Mr Paul STUART, Professor, Department of Chemical Engineering
Fellow – Canadian Academic of Engineering (CAE)
Fellow-Pulp and Paper Technical Association of Canada (PAPTAC)
http://www.polymtl.ca/recherche/rc/en/professeurs/details.php?NoProf=249&Langue=A

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#15: Area of Expertise: Chemical Engineering

Research Project Title

Controlling Catalyst Concentrations in a Photochemical Surface Engineering Process

University Cycle

Priority will be given to 1st cycle (undergraduate) and 2nd cycle (Master), but 3rd cycle (Ph.D.) candidates are also welcome to apply)

Background Information

For many applications, materials need to serve multiple functions at the same time. Some of these functions stem from their bulk properties (e.g.: mechanical strength, thermal conductivity), while others are surface-driven (e.g.: wettability, reactivity, biocompatibility). Often, we need the surface of a material to serve a different function from what its native properties allow. In that case, we must engineer the surface to meet the needs of a given process. Photo-initiated chemical vapour deposition (PICVD) shows promise as a scalable process to facilitate surface engineering. Work at Polytechnique Montreal's PhotoSEL (photochemical surface engineering laboratory) has focused lately on adapting this method at near atmospheric pressure and under mild conditions to tailor the surface properties of metal surfaces, polymer substrates and nanoparticles of various types at both small and large scales. This internship would aim to improve precursor preparation and control the appearance of specific catalyst species.

Main Tasks during the Internship

- Pursue the investigation of a novel photochemical surface treatment approach, photo-initiated chemical vapour deposition (PICVD)
- Gain insight into the kinetics of the process, and the effect of contaminants
- Characterize the treated surfaces chemically and physically
- Design a reactor to control the appearance of specific catalyst species

Required Skills for the Internship

- Reactor engineering and operation
- Surface characterization techniques (tensiometry, zeta potential, XPS, FTIR)
- Gas phase characterization (GC-MS, IR)
- Very strong communications skills
- Lab safety

Location

Main Building

Supervisor

Mr Jason Robert TAVARES, Associate Professor, Department of Chemical Engineering
http://www.polymtl.ca/recherche/rc/en/professeurs/details.php?NoProf=456&Langue=A

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#16: Area of Expertise: Chemical Engineering

Research Project Title

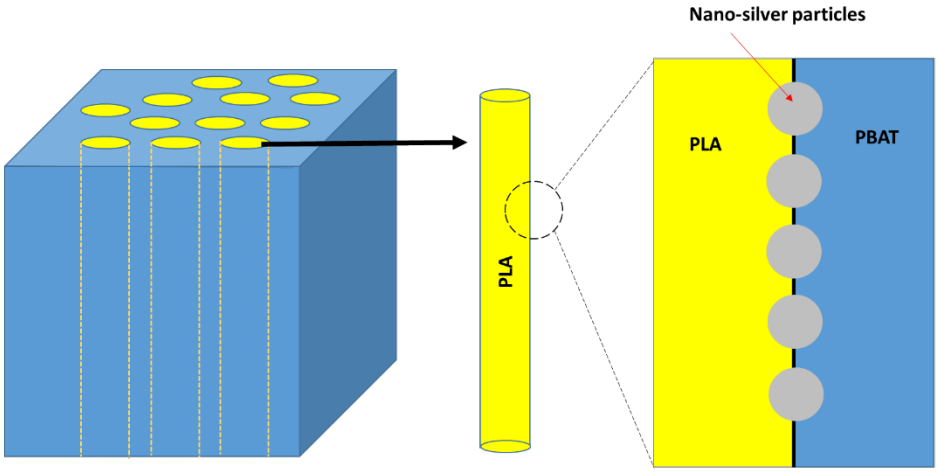
Polymeric Pressure Sensors Based on Multiphase Bioplastic Nanocomposites

University Cycle

1st cycle (undergraduate), 2nd cycle (Master) or 3rd cycle (Ph.D.)

Background Information

Pressure sensors have a very wide range of applications including, but not limited to, touch sensitive buttons, electrical pressure gauges and pulse sensors. Most of present pressure sensors are based on piezoelectric materials such as doped silicon; however, these materials are relatively expensive and have difficulties in handling and processing which have limited their applications. Recently, polymeric pressure sensors have received much attention due to their low cost and ease of processing. In this project, a new type of polymeric pressure sensor based on interfacial localization of conductive nano-silver particles at the interface of poly(lactic acid), PLA, and poly(butylene adipate-co-terphthalate), PBAT, blends will be studied. PLA/PBAT blend is a fully biocompostable bioplastic blend which shows a good balance between stiffness and toughness in mechanical properties. This blend has been shown to have a fibrillar morphology [1] in which the dispersed phase exists in the form of fibers (see the following schematic). In addition, previous studies pointed to the high potential of localization of different type of nanoparticles at the interface of this system by tuning mixing strategy and viscosity of phases [2-4]. In this study, by controlling the processing condition and viscosity of phases, nano-silver particles will be localized at the interface of PLA/PBAT blends. By controlling the processing parameters, an oriented fibrillar structure similar to the following structure will be produced using melt extrusion.



These steps will produce an oriented fibrillar morphology with nano-silver particles localized at its interface. Applying a compressive pressure in the direction of fibers will reduce the inter-particle distance of nano-siliver particles and, consequently, will reduce the resistivity. This change in the resistivity will be correlated to the applied pressure. On the other hand, applying a tensile stress will increase the inter-particle distance of nano-silver particles and will increase the resistivity of the nanocomposite. As a result, the final nanocomposite can be used as a pressure sensor which can translate both compressive and tensile pressures into resistivity variation.

References

[1] E. Jalali Dil, et al., Polymer (2015), 68, 202.
[2] E. Jalali Dil, B. D. Favis, Polymer (2015), 76, 295.
[3] E. Jalali Dil, et al., Eur. Polym. J. (2016), 85, 187.
[4] E. Jalali Dil, et al., Eur. Polym. J. (2016), 85, 638.

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Main Tasks during the Internship

- Plan and execute with the supervisor the experiments for the preparation of material samples to be tested and their testing

Required Skills for the Internship

- Autonomy
- Curiosity
- Equivalent of 3rd year chemical or physical engineering

Location

Main Building

Supervisor

Mr Abdellah AJJI, Professor, Department of Chemical Engineering
http://www.polymtl.ca/recherche/rc/en/professeurs/details.php?NoProf=391&Langue=A

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#17: Area of Expertise: Civil, Geological or Mining Engineering

Research Project Title

Development of Ultra-High Performances Fiber Reinforced Concretes and Characterization of their Mechanical Properties

University Cycle

1st cycle (undergraduate), 2nd cycle (Master) or 3rd cycle (Ph.D.)

Background Information

In the last decade a new type of very durable concrete have been developed, it is named ultra-high performances fiber reinforced concretes (UHPFRC). They present very high mechanical properties, and very low porosity and permeability. One UPFRC have been produced at Polytechnique Montreal. The goal of the internship will be to modify the UHPFRC mix in order to reduce its CO2 emissions and increase its mechanical properties by using special mineral admixture.

Main Tasks during the Internship

- Produce UHPFRC mixes at the laboratory
- Measure UHPFRC properties at fresh state with standard laboratory tests (temperature, air content, volumetric weight, etc.)
- Measure UHPFRC properties at hardened state with standard laboratory tests (compressive strength, tensile strength, flexural strength, etc.)
- Analysis of results
- Produce a technical report

Required Skills for the Internship

- Have an excellent leadership and be autonomous to manage technical activities
- Have a good knowledge of concrete production and concrete properties
- Have a good dexterity and be familiar with manual works in order to carry out lab activities
- Have an excellent knowledge of Excel and Word software in order to analyze test results and prepare the technical report
- Having an experience in laboratory activities would be very valuable.

Location

Main Building

Supervisor

Mr Jean-Philippe CHARRON, Professor, Department of Civil, Geological and Mining Engineering
http://www.polymtl.ca/recherche/rc/en/professeurs/details.php?NoProf=303&Langue=A

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#18: Area of Expertise: Civil, Geological or Mining Engineering

Research Project Title

Evaluation of the Durability of Fiber Reinforced Concretes in Realistic Conditions Found in Structures

University Cycle

1st cycle (undergraduate), 2nd cycle (Master) or 3rd cycle (Ph.D.)

Background Information

Durability of concrete structures depends mainly on concrete quality, presence of cracks within concrete and environmental expositions. Durability of concrete is generally evaluate on uncracked concrete specimens, which is not representative of real structure conditions. The goal of the internship will be to realize standard durability tests on cracked concrete specimens in order to provide unique and more realistic information on the durability of structures.

Main Tasks during the Internship

- Produce conventional concrete and fiber reinforce concrete mixes at the laboratory
- Realize tensile tests on concrete specimens in order to create cracks are various sizes within specimens
- Measure concrete durability after specimens have been cracked with standard laboratory tests (diffusion tests, permeability tests, absorption tests, porosity tests)
- Analysis of results
- Produce a technical report

Required Skills for the Internship

- Have an excellent leadership and be autonomous to manage technical activities
- Have a good knowledge of concrete production and concrete properties
- Have a good dexterity and be familiar with manual works in order to carry out lab activities
- Have an excellent knowledge of Excel and Word software in order to analyze test results and prepare the technical report
- Having an experience in laboratory activities would be very valuable.

Location

Main Building

Supervisor

Mr Jean-Philippe CHARRON, Professor, Department of Civil, Geological and Mining Engineering
http://www.polymtl.ca/recherche/rc/en/professeurs/details.php?NoProf=303&Langue=A

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#19: Area of Expertise: Civil, Geological or Mining Engineering

Research Project Title
Experimental Investigation on Transient Flow in Stormwater Systems (SWS)

University Cycle
2nd cycle (Master) or 3rd cycle (Ph.D.)

Background Information
Current design methods for Storm Water Systems (SWS) are based on simplified representations of energy and continuity equations. This oversimplified design of SWS has led to severe problems and costly damage to sewers (geysers, overflows, street inundations, traffic accidents and also severe electrical problems). An illustration of one of these problems happened in Montreal in 2011, where a manhole located on Wolfe Street, between the streets René-Lévesque and Sainte-Catherine, was turned into a veritable geyser on Monday July 18th, projecting sprays of storm water several meters high. Pressurized air that was blocked in the storm sewer tried to escape, taking with it large amounts of storm water. A car parked on the manhole metal cover was even violently raised repeatedly.

Main Tasks during the Internship
- Analyzing the occurrence conditions of the transient flow in SWS;
- Modelling the SWS boundary conditions and analyzing the pressurized/depressurized wave front behaviour and trapped air pockets propagating in SWS

Required Skills for the Internship
Excellent skills in hydraulics and in lab works

Location
Main Building

Supervisor
Mr Musandji FUAMBA, Associate Professor, Department of Civil, Geological and Mining Engineering
http://www.polymtl.ca/recherche/rc/en/professeurs/details.php?NoProf=317

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#20: Area of Expertise: Civil, Geological and/or Mining Engineering

Research Project Title

Valorization and Integrated Management of Mine Wastes to Limit the Generation of Contaminated Drainage Water

University Cycle

1st cycle (undergraduate), 2nd cycle (Master) or 3rd cycle (Ph.D.)

Background Information

One of the most critical issues for the mining industry remains the management and safe disposal of the important quantities of solid wastes (mine tailings and waste rock) produced during the operations. These materials often contain sulfides which can oxidize upon contact with oxygen (air) and water, producing acidic effluent with high concentrations of sulfates and heavy metals (known as acid mine drainage, AMD). Reclamation of reactive waste disposal sites is best achieved when it is planned in advance and integrated into the mining production cycle. Integrated mine waste management is therefore at the core of the research carried out by RIME.

Main Tasks during the Internship

The student's main task will be to characterize the hydrogeological, geotechnical and geochemical properties of different mine wastes, of various grain size and mineralogy. Using both standardized tests and physical models in the laboratory, the objective will be to compare experimental measurements with field results and predictive models. In addition, the student will be involved in several projects and will help MSc and PhD students with their respective experimental works (characterization, monitoring, etc.). Some initiation to numerical modelling will be provided. Depending on the student's background and interests, the internship may focus on co-disposal of mine tailings and waste rocks in open pits, valorization of waste rocks in roads, dams and cover systems, and/or effects of climate change on mining sites.

Required Skills for the Internship

- Basic knowledge in hydrogeology and geotechnical engineering.
- Curiosity and interest for research

Location

Main Building

RIME - Hydrogeology and mining environment laboratory

The Research Institute on Mines and Environment (RIME) UQAT-Polytechnique was founded in 2013 by the Université du Québec en Abitibi-Témiscamingue and Polytechnique Montréal. The only one of its kind in Quebec, this joint research program was created in association with several mining industry partners. Focused on the environment and tailings management, the Research Institute develops innovative environmental solutions for the entire life cycle of a mine. For more information, visit: http://www.irme.ca/en/

Supervisor

Mr Thomas PABST, Assistant Professor, Department of Civil, Geological and Mining Engineering
http://www.polymtl.ca/recherche/rc/en/professeurs/details.php?NoProf=582&Langue=A

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#21: Area of Expertise: Civil, Geological or Mining Engineering

Research Project Title
Activity Recognition in Public Spaces

University Cycle
2nd cycle (Master) or 3rd cycle (Ph.D.)

Background Information
The objective is to recognize various activities in streets and public spaces relevant for transportation, e.g. walking, running, jogging, queueing, strolling, chatting, etc., from video data so that the use of these public spaces can be automatically analyzed. The project will be adapted to the candidate's level.

Main Tasks during the Internship
- Brief review of existing methods for activity recognition from video data
- Implementation and refinement of the most promising methods
- Validation of the methods on real dataset, either existing or to be collected in Montreal during the project
- Development of methods for joint tracking, scene understanding and activity recognition (time permitting)

Required Skills for the Internship
- Good programming skills, or a willingness to learn at least a high-level programming language such as Python
- Good and rigorous software engineering habits to develop code that can be maintained over the long term (version control, compilation process using Make or CMake, etc.) (or willingness to learn)
- Some knowledge of computer vision and machine learning

Location
Main Building

Supervisor
Mr Nicolas SAUNIER, Associate Professor, Department of Civil, Geological and Mining Engineering
http://www.polymtl.ca/recherche/rc/en/professeurs/details.php?NoProf=418

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#22: Area of Expertise: Civil, Geological or Mining Engineering

Research Project Title
Tracking Road Users from Unmanned Aerial Vehicles (UAVs)

University Cycle
1st cycle (undergraduate) or 2nd cycle (Master)

Main Tasks during the Internship
- Brief review of methods for tracking moving objects from UAVs
- Comparison with an existing open source tracker developed at Polytechnique and selection of tracking method (either a refinement of the tracker or a method from the literature)

Required Skills for the Internship
- Good programming skills, i.e. at least the working knowledge of an object-oriented programming language like C++, Java or Python
- Good and rigorous software engineering habits to develop code that can be maintained over the long term (version control, compilation process using Make or CMake, etc.)
- It is desired but not required to have some knowledge of computer vision and machine learning
- Knowledge of Linux and the OpenCV library is a plus

Location
Main Building

Supervisor
Mr Nicolas SAUNIER, Associate Professor, Department of Civil, Geological and Mining Engineering
http://www.polymtl.ca/recherche/rc/en/professeurs/details.php?NoProf=418

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#23: Area of Expertise: Civil, Geological or Mining Engineering

Research Project Title
Framework for the Systematic Validation of Tracking Improvements

University Cycle
1st cycle (undergraduate) or 2nd cycle (Master)

Main Tasks during the Internship
- Choosing an optimization approach to optimize tracking parameters based on tracking annotations (ie tracker training)
- Designing a cross-validation framework on a set of annotation videos, training on each video in turn and evaluating the tracking performance on the rest
- Testing the new framework with a few variations of an existing open source tracker (time permitting)

Required Skills for the Internship
- Good programming skills, i.e. at least the working knowledge of an object-oriented programming language like C++, Java or Python
- Good and rigorous software engineering habits to develop code that can be maintained over the long term (version control, compilation process using Make or CMake, etc.)
- It is desired but not required to have some knowledge of computer vision and machine learning
- Knowledge of Linux and the OpenCV library is a plus

Location
Main Building

Supervisor
Mr Nicolas SAUNIER, Associate Professor, Department of Civil, Geological and Mining Engineering
http://www.polymtl.ca/recherche/rc/en/professeurs/details.php?NoProf=418

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#24: Area of Expertise: Computer and Software Engineering

Research Project Title
Identifying Bottlenecks in Build System Performance

University Cycle
1st cycle (undergraduate) or 3rd cycle (Ph.D.)

Background Information
When mentioning the term "software development", people immediately think about source code and programmers. Of course, many more activities play a role in software development, and many more artifacts than just the source code. One such artifact is the build system. This is the crucial infrastructure that developers use on a daily basis to compile and package the source code into executables and other deliverables, such that the developers can test their software after adding a new feature or bug fix. People typically use technologies like GNU Make, autotools, Maven, Ant, SCons, Rake, CMake or Gradle to implement their build system.

Since build systems are used so often and the software system that they build typically is huge, developers risk losing a lot of time waiting for their build to finish. It is not uncommon for very large systems to require hours to finish a build. For this reason, most build technologies provide incremental build modes to minimize the time a build takes, by just re-building the source code files that changed and reusing the previously built version of other files. In addition, most technologies also provide parallel build support that builds multiple files at the same time.

However, build technologies are not understood very well by software developers, and often use arcane technology that is hard to change. Furthermore, although build systems play a central role in software development, surprisingly little research has been performed on them up until a couple of years ago, and most of this research focused on the quality of the actual build system instead of on build system performance. As such, many companies end up with a slow build system and no concrete idea on how to speed up the build.

The goal of this internship is to study how the performance of a build system evolves during daily development, analyze and document which build system or source code changes are related to build system performance degradations and improvements, and apply our findings on a concrete open source system to validate our findings. This work will build on our existing MAKAO infrastructure for reverse-engineering GNU Make build systems (http://mcis.polymtl.ca/makao.html) as well as a new framework developed during a previous internship.

Similar to energy consumption in software, the performance of a build system cannot be easily estimated statically using just the build system code, one needs to run and measure the build process. Such measurements need to be done on multiple build configurations (a set of features to build on a specific platform and architecture). This is because a developer might have introduced a build problem on his development platform, but not on the other ones, or one specific feature might result in extra build steps to be executed for all other components of the system.

Once we have measured the performance per configuration, we automatically know how much time each file takes to build. We can use this information to calculate (instead of measure) the performance of incremental builds. For this, we can exploit MAKAO's underlying model of a build system execution. This model knows all the dependencies followed by the build system during execution, so it allows to find out which files need to be recompiled when a particular file changes.

Given the differences in programming languages, build system technologies and software project sizes, we will perform our measurements for multiple systems and multiple versions. For each of these, we will analyze the evolution of build performance across time using statistical techniques and visualizations. We will determine statistically significant increases and decreases in performance between versions, as well as fluctuation-heavy parts of the build system. We can also compare build performance per programming language, build technology and project size. In the end, our aim is to develop techniques and tools to help practitioners understand and improve the performance of their build system.

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Main Tasks during the Internship
The project basically consists of a large empirical study on "real" open source distributions and projects. Our lab has significant expertise in such studies as well as the necessary tools and infrastructure. Since the more projects are analyzed, the better, more than one student can work on this project.

This proposal largely consists of the 3 typical software intelligence phases:
(1) Data Extraction: The student will search for open source systems with sufficient development history and online data sources, such as bug reports, mailing list messages and online fora. Then, the student needs to build multiple versions, for different configurations.

(2) Quantitative Analysis: The student first will gather simple statistics, like the evolution of the performance of full builds. This will give an initial idea about the scale of the data as well as possibly interesting parts of the data. Second, the performance of incremental builds will be calculated, followed by analysis of the resulting incremental performance.

(3) Qualitative Analysis: The student will manually study code changes and documentation for the versions with build system performance drops. By analyzing the qualitative data like mailing list discussions, the student will be able to identify possible causes of the performance problems. Through interaction with other people in the lab, these causes can be fleshed out into more general patterns that can be documented in a structured way.

The project is quite large in scope, so multiple internships could be offered. Furthermore, we believe that completion of phases (1) and (2) with some initial results for phase (3) would be a successful outcome of this project.

Required Skills for the Internship
Through this project, students will become experts in software intelligence, an emerging area many companies are trying to get into. To extract data, a student needs the motivation to actively contact open source developers, search online data sources, understand their format and interconnections, and use scripting languages (bash, perl, python, ...). For the quantitative analysis, (s)he again needs scripting languages and the desire to learn the R language to visualize data. For the qualitative analysis, (s)he needs persistence, conscience and patience to read through and summarize textual artifacts like bug reports and email threads.

About Us:
The lab on Maintenance, Construction and Intelligence of Software (MCIS) studies ultra-large scale software systems and the development processes and tools used to build them, in order to identify bottlenecks and problems, and to come up with innovative solutions and support. These solutions and support enable developers, testers, team leads, and everyone up until management level to develop software more effectively and in a better informed way, such that the typical risks associated with software development (not making the deadline, insufficient quality or running out of resources) are reduced or even mitigated.

In the context of this proposal, the mission of MCIS is to help practitioners understand and improve the performance of their build system. Through empirical research on software development process data stored in revision control systems (Subversion, Git, ...), mailing list archives, bug repositories (Bugzilla, Jira, ...), online documentation and any other kind of data source available, we build models and distill process knowledge that are immediately applicable in practice.

Location:
Lassonde Building

Supervisor
Mr Bram ADAMS, Assistant Professor, Department of Computer and Software Engineering
http://www.polymtl.ca/recherche/rc/en/professeurs/details.php?NoProf=514&Langue=A
http://mcis.polymtl.ca/

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#25: Area of Expertise: Computer and Software Engineering

Research Project Title
P-MARt

University Cycle
1st cycle (undergraduate) or 3rd cycle (Ph.D.)

Background Information
In the 1960's, the advances in computer hardware was making it more and more difficult for hardware engineers to write the software needed to harness the computing power and operational complexity of new computers, which led to the software engineering crisis and the birth of software engineering as an engineering discipline. Since then, software engineering has made great progress and proposed processes, e.g. agile methods for distributed teams, methods, e.g., interactive debugging, and tools, e.g., refactorings, to harness complexity. Yet, its focus has been mostly on software for "big box" consumer computers or for "well-defined" embedded systems, the former with lots of computing power and network connection, the latter with clear specifications and "slow" development cycle.

This focus is still relevant nowadays but must expand to two news "emerging" categories of systems. The first category includes all the networks of (intermittently) connected, heterogeneous devices with ill-defined and changing functionalities: the Internet of Things (IoT), which was put forward by Sun Microsystems and others and connects devices, animals, and people. Example scenarios of the IoT involve drought and forest fire prevention through environmental monitoring, energy management in smart homes to automatically adjust energy consumption depending on the occupants' habits, automatic checkout of groceries without scanning items individually at the cashier, and health monitoring and faster intervention in emergency situations.

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Main Tasks during the Internship
There do not exist "normal" software systems anymore: the computing power and complexity of novel systems, like Cloud services and devices connected to the IoT make all systems complex. To tackle the complexity of these systems, developers often resort to well-known programming idioms, design patterns, and architectural styles. However, the positive impact of these idioms, patterns, and styles is still an open-research question. To answer this question, one research direction focuses on collecting, cataloguing, and analysing "true" occurrences of these idioms, patterns, and styles to assess their real impact in real contexts. The aim of this project is to continue evolving the P-MARt repository (http://www.ptidej.net/tools/designpatterns/index_html#2) of instances of idioms, patterns, and styles with other instances and performing analyses to understand the real impact of these instances and studying their evolution.

Required Skills for the Internship
Good programming skills, any programming language. Good design and architectural knowledge. Through this project, students will deepen their understanding of programming and designing and will become experts in pattern-based software quality.

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#26: Area of Expertise: Computer and Software Engineering

Research Project Title
Improving Developers' IDEs

University Cycle
2nd cycle (Master) or 3rd cycle (Ph.D.)

Background Information
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Main Tasks during the Internship
Software engineering is intrinsically a human endeavour. Although it is based on sound mathematical and engineering principles, software developers play an important role during the development of software systems because, essentially, no two systems are identical. Therefore, the creativity of software developers as much as their expertise and experience are important during software development. Yet, the tools offered to software developers have often been built without explicitly considering the creativity of software developers. Therefore, the tools offered to software developers must be studied to understand how they help and impede software developers in general and their creativity in particular. Our laboratory uniquely owns eye-tracker systems to study software developers' use of tools to understand this use, to identify blocks to their creativity, and to recommend improvements.

Required Skills for the Internship
Good programming skills in Java. Interest in human-computer interactions. Knowledge of empirical studies. Through this project, the students will contribute to the advancement of the tooling for software developers, develop unique skills related to controlled and quasi-experiments, and will contribute to the development of more adequate software development tools.

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#27: Area of Expertise: Computer and Software Engineering

Research Project Title
Multi-language Parsers

University Cycle
1st cycle (undergraduate), 2nd cycle (Master) or 3rd cycle (Ph.D.)

Background Information
In the 1960's, the advances in computer hardware was making it more and more difficult for hardware engineers to write the software needed to harness the computing power and operational complexity of new computers, which led to the software engineering crisis and the birth of software engineering as an engineering discipline. Since then, software engineering has made great progress and proposed processes, e.g. agile methods for distributed teams, methods, e.g., interactive debugging, and tools, e.g., refactorings, to harness complexity. Yet, its focus has been mostly on software for "big box" consumer computers or for "well-defined" embedded systems, the former with lots of computing power and network connection, the latter with clear specifications and "slow" development cycle. This focus is still relevant nowadays but must expand to two news "emerging" categories of systems. The first category includes all the networks of (intermittently) connected, heterogeneous devices with ill-defined and changing functionalities: the Internet of Things (IoT), which was put forward by Sun Microsystems and others and connects devices, animals, and people. Example scenarios of the IoT involve drought and forest fire prevention through environmental monitoring, energy management in smart homes to automatically adjust energy consumption depending on the occupants' habits, automatic checkout of groceries without scanning items individually at the cashier, and health monitoring and faster intervention in emergency situations. The second category includes ultra-large scale systems that collect, store, analyse, and report on all the data generated by enterprises, by citizens, and, of course, by devices in the Internet of Things. These ultra-large scale systems include, but are not limited to, cloud platforms, REST services, map-reduce engines, NoSQL and in-memory databases. Example of ultra-large scale systems are point-of-sales systems connected to distributed, replicating in-memory databases in a large chain of grocery stories, which collect and store each and every items bought by clients and which analyse and report on the sales to improve the supply chain, to identify local trends, to forecast on the need for new items to satisfy clients' demands.

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Main Tasks during the Internship
The Ptidej Team develop a unique tool suite composed of a generic and extensible meta-model to describe programs and to analyse their quality and a set of parsers to create models of programs in different programming languages. In particular, it has developed parsers for Java (source code and byte-code) and C++ (source code). It has also developed a parser for JavaScript. In this project, the students will contribute to evolving the JavaScript parser to create PADL models of JavaScript programs that are more precise and more useful for various kinds of analyses.

Required Skills for the Internship
Excellent Java and JavaScript programming skills. Knowledge of parsing and related concepts. Through this project, the students will acquire a unique perspective on the analysis of multi-language systems, which are nowadays the norms, with systems often comprising components in five or more programming languages (CSS, HTML, JavaScript, Java, C++, and SQL).

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#28: Area of Expertise: Computer and Software Engineering

Research Project Title
Software Designs Analyses

University Cycle
1st cycle (undergraduate)

Background Information
In the 1960's, the advances in computer hardware was making it more and more difficult for hardware engineers to write the software needed to harness the computing power and operational complexity of new computers, which led to the software engineering crisis and the birth of software engineering as an engineering discipline. Since then, software engineering has made great progress and proposed processes, e.g. agile methods for distributed teams, methods, e.g., interactive debugging, and tools, e.g., refactorings, to harness complexity. Yet, its focus has been mostly on software for "big box" consumer computers or for "well-defined" embedded systems, the former with lots of computing power and network connection, the latter with clear specifications and "slow" development cycle.

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Main Tasks during the Internship
The PADL meta-model developed by the Ptidej Team to represent programs in various programming languages can also describe designs. The student will integrate into the Ptidej Tools Suite the SDMetrics libraries for parsing XMI to create PADL models from XMI models (http://models-db.com/).

Required Skills for the Internship
Knowledge of the XML meta-language. Good Java programming skills. Through this project, the student will further develop skills in programming by working on a large-scale tools suite that has been evolving for a decade. The student will also gain valuable skills in software designs and quality analyses.

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#29: Area of Expertise: Computer and Software Engineering

Research Project Title
On-line Software Quality Analyser

University Cycle
1st cycle (undergraduate)

Background Information
In the 1960's, the advances in computer hardware was making it more and more difficult for hardware engineers to write the software needed to harness the computing power and operational complexity of new computers, which led to the software engineering crisis and the birth of software engineering as an engineering discipline. Since then, software engineering has made great progress and proposed processes, e.g. agile methods for distributed teams, methods, e.g., interactive debugging, and tools, e.g., refactorings, to harness complexity. Yet, its focus has been mostly on software for "big box" consumer computers or for "well-defined" embedded systems, the former with lots of computing power and network connection, the latter with clear specifications and "slow" development cycle.

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Main Tasks during the Internship
The Ptidej Team develops an on-line software quality analysis tool (http://www.ptidej.net/team/projects/"brunch.soccerlab.polymtl.ca"). The project consists in contributing to this quality analysis tools by improving its usability (Web programming) and its feature (back-end programming). The Web programming includes securing the tool, improving its visual quality, implementing Ajax interactions. The back-end programming includes making available more features from the Ptidej Tools Suite, leveraging multi-code programming for parallelising computations, supporting high performance databases.

Required Skills for the Internship
Excellent Web technologies or Java programming skills. Databases, including if possible NoSQL and in-memory databases. Distributed programming. Through this project, the student will learn the development of Web application from the front-end to the back-end, including all the technologies used by forefront companies: Glassfish, Graddle, MongoDB, etc.

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#30: Area of Expertise: Computer and Software Engineering

Research Project Title
Low Foot-print Meta-model for Ultra-large Scale Systems

University Cycle
1st cycle (undergraduate) or 2nd cycle (Master)

Background Information
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Main Tasks during the Internship
At the core of the Ptidej Tools Suite is the PADL meta-model to describe programs in various programming languages, including but not limited to object-oriented programming languages (C++, Java) and prototype-based programming languages (JavaScript). The models built for large programs can themselves amount to mega- or gigabytes of data. The student will perform profiling analyses to identify the time and memory bottlenecks and evolve the PADL meta-model to reduce memory foot-print and allow "on-the-fly" loading/unloading of parts of the models.

Required Skills for the Internship
Excellent Java programming skills, a plus would be the use of Java reflection. Interest in programming languages. Knowledge of meta-modeling. Through this project, the students will learn invaluable skills about performance analyses and apply these skills to a real, large-scale system. These skills are thought after by companies who must deal with larger and larger datasets.

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#31: Area of Expertise: Computer and Software Engineering

Research Project Title
Visualisations for Ultra-large Scale Systems

University Cycle
1st cycle (undergraduate) or 2nd cycle (Master)

Background Information
In the 1960's, the advances in computer hardware was making it more and more difficult for hardware engineers to write the software needed to harness the computing power and operational complexity of new computers, which led to the software engineering crisis and the birth of software engineering as an engineering discipline. Since then, software engineering has made great progress and proposed processes, e.g. agile methods for distributed teams, methods, e.g., interactive debugging, and tools, e.g., refactorings, to harness complexity. Yet, its focus has been mostly on software for "big box" consumer computers or for "well-defined" embedded systems, the former with lots of computing power and network connection, the latter with clear specifications and "slow" development cycle.

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Main Tasks during the Internship
The Ptidej Tools Suite integrates several different user-interfaces, including Swing-based and a Web-based interfaces. These interfaces use dedicated toolkits to display programs as UML-like class diagrams, enriched with quality-related information. This project aims at integrating new visualisation techniques and new libraries, such as PlantUML (http://plantuml.com/) into the Ptidej Tools Suite, either in the Swing-based and–or the Web-based interfaces. Thus, the student will contribute to the understanding of programs and of their quality.

Required Skills for the Internship
Java programming as well as, if possible, graphic toolkits and visualisation libraries. Web programming is a must if the student is to add new visualisations to the Web interface. Through this project, the student will put to use designing and development skills for a real, large scale system and learn various graphical toolkits and libraries. Knowledge of these toolkits and libraries as well as experience gained in integrating them into real user-interfaces are interesting to many companies.

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#32: Area of Expertise: Computer and Software Engineering

Research Project Title
Parallelisation of Parsing and Fine-grain Evolution of Models

University Cycle
2nd cycle (Master) or 3rd cycle (Ph.D.)

Background Information
In the 1960's, the advances in computer hardware was making it more and more difficult for hardware engineers to write the software needed to harness the computing power and operational complexity of new computers, which led to the software engineering crisis and the birth of software engineering as an engineering discipline. Since then, software engineering has made great progress and proposed processes, e.g. agile methods for distributed teams, methods, e.g., interactive debugging, and tools, e.g., refactorings, to harness complexity. Yet, its focus has been mostly on software for "big box" consumer computers or for "well-defined" embedded systems, the former with lots of computing power and network connection, the latter with clear specifications and "slow" development cycle. This focus is still relevant nowadays but must expand to two news "emerging" categories of systems. The first category includes all the networks of (intermittently) connected, heterogeneous devices with ill-defined and changing functionalities: the Internet of Things (IoT), which was put forward by Sun Microsystems and others and connects devices, animals, and people. Example scenarios of the IoT involve drought and forest fire prevention through environmental monitoring, energy management in smart homes to automatically adjust energy consumption depending on the occupants' habits, automatic checkout of groceries without scanning items individually at the cashier, and health monitoring and faster intervention in emergency situations.

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Main Tasks during the Internship
The Ptidej Tools Suite is based on the PADL meta-model to describe programs written in different programming languages (including but not limited to C++ and Java). Building PADL models require parsing the source code of programs and applying various analyses. These models may represent various versions of the same programs. However, as of today, these models are built from the complete source code of each program and each version. We want to parallelise the parsing of the source code and allow the fine-grain evolution of models to speed up the creation of models.

Required Skills for the Internship
Java programming as well as strong knowledge of compilation and parallel programming. Being proficient with differencing algorithms and tools (à la diff) is an asset. Knowledge of change-impact analyses would help.

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#33: Area of Expertise: Electrical Engineering

Research Project Title
Radar Signal Processing Algorithms and Their Implementation on FPGA

University Cycle
1st cycle (undergraduate), 2nd cycle (Master) or 3rd cycle (Ph.D.)

Background Information
Microwave Doppler and FMCW radars can be used in many applications, such as human vital sign and gait detection, structural health monitoring, through-the-wall life detection, speed and range detection, and so on.

The overall project covers several technical challenges of radar signal processing including null detection point problem, DC offset problem, measurement accuracy enhancement and multi-target recognition. Novel hardware architectures and signal processing techniques are jointly researched for reliable and robust operation. The trainee(s) are expected to contribute to the project by assessing the computation complexity of our developed algorithms as well as implement on advanced FPGA platform.

Main Tasks during the Internship
Realize digital signal processing algorithms on FPGA.

Required Skills for the Internship
- Solid knowledge of hardware description language (HDL) and experience in FPGA development.
- Skilled in programing with Matlab, C/C++.
- Knowledge of digital signal processing, A/D and D/A conversion, DSP techniques, and microcontroller programing.
- Comfortable to work in both team and independent settings.
- Capability of working within project schedules and multi-tasking to meet deadlines.
- Fluent English.

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Mr Ke WU, Professor, Department of Electrical Engineering,
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#34: Area of Expertise: Electrical Engineering

Research Project Title
Development of Interactive GUI Applications for Radar and Sensing Applications

University Cycle
1st cycle (undergraduate), 2nd cycle (Master) or 3rd cycle (Ph.D.)

Background Information
As part of the radar and sensing project and for visually appealing demonstration, the graphic user interface (GUI) will be developed on PC as well as mobile computing platforms such as smart phone or open source mini computers. The trainee(s) are expected to contribute to the project by architecting and coding a software package which displays the detected objectives & parameters, and communicates with other hardware through physical data interfaces.

Main Tasks during the Internship
GUI application development

Required Skills for the Internship
- Experiences in GUI application development on PC or mobile platform.
- Solid background of C++, C# or Java on Windows (IoT core) or Linux.
- Knowledge of micro controllers and single-board computers (Raspberry Pi, Intel Edison, Joule, …).
- Knowledge of basic hardware interfaces (GPIO, I2C, SPI, UART, …), data access and control with sensors, actuator and touch screen.
- Knowledge of FPGA and HDL is a plus.
- Comfortable to work in both team and independent settings.
- Capability of working within project schedules and multi-tasking to meet deadlines.
- Fluent English.

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#35: Area of Expertise: Electrical Engineering

Research Project Title
Distributed Robotics

University Cycle
1st cycle (undergraduate)

Background Information
We are developing two experimental systems for distributed robotics, using ground robots as well as nano-quadrotors. One possible project would be to develop and implement a cooperative localization algorithm where the robots localize each other in a group simply from pairwise distance measurements obtained from a previously developed RF ranging system.

More information on our activities can be found here:
http://www.professeurs.polymtl.ca/jerome.le-ny/
http://www.polymtl.ca/robotique-mobile/en

Main Tasks during the Internship
Some background in one or more of the following areas is desired: robotics, control systems, embedded system programming, computer vision, embedded system design (hardware), signal processing.

Required Skills for the Internship
The specific tasks of the student will be adapted based on his technical background and interests (ex: interest in theory vs. system design and programming), as well as the state of the project at the time of his/her arrival. The student will be involved in tasks such as:

- Developing a tailored simulation/rapid prototyping environment for testing of algorithms.
- Developing the hardware and low level embedded software for the multi-robot setup.
- Implementing algorithms for localization and control (trajectory tracking) in software.
- Designing new multi-robot coordination algorithms.
- Programming robots via ROS (Robot Operating System) to execute the algorithms.
- etc.

Location
Lassonde Building

Supervisor
Mr Jérôme LeNY, Assistant Professor, Department of Electrical Engineering
http://www.polymtl.ca/recherche/rc/en/professeurs/details.php?NoProf=546&Langue=A

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#36: Area of Expertise: Mechanical Engineering

Research Project Title
Product Design Support Based on Kansei Engineering

University Cycle
1st cycle (undergraduate) or 3rd cycle (Ph.D.)

Background Information
Kansei engineering, also known as emotional / affective engineering aims at the development or improvement of products and services by translating the customer's psychological feelings and needs into the domain of the parameters of product design.

This project focuses on the development of a design support tool for product design. Data collected for the design of vases will be used as a learning set case study.

The student will work on developing statistical based as well as AI based design support tools. The goal of the tool is to give guidelines to designers on how to achieve or evoke a specific perception into the user by manipulating geometric properties of the vase.

Main Tasks during the Internship
- Analyze the available data set and complete it if necessary.
- Analyze the chosen parameters and their influence on human perception.
- Determine the best parameters to optimize the link between geometry and perception.
- Develop a model for emotion/perception prediction based on geometric properties.
- Write a technical report on the results.

Required Skills for the Internship
- The interested student should have basic knowledge of coding in MATLAB but C++ is a plus.
- The interested student should have knowledge in Product Design and Design Methods.
- Knowledge of Emotional Design is a plus.

Location
Main Building

Supervisor
Mr Sofiane ACHICHE, Associate Professor, Department of Mechanical Engineering
http://www.polymtl.ca/recherche/rc/en/professeurs/details.php?NoProf=540&Langue=A

Mr Aurelian VADEAN, Assistant Professor, Department of Mechanical Engineering
http://www.polymtl.ca/recherche/rc/en/professeurs/details.php?NoProf=288&Langue=A

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#37: Area of Expertise: Mechanical Engineering

Research Project Title
Design and Prototyping of a Planar Differentially Driven Cable Robot

University Cycle
1st cycle (undergraduate), 2nd cycle (Master) or 3rd cycle (Ph.D.)

Background Information
Cable manipulators are particular parallel robots where cables are used instead of rigid linkages to manipulate the moving platform (MP). This characteristic gives special properties to these mechanisms. That means in addition to some advantages of linkage-driven parallel robots, they have a simple structure, lightness and low inertia of the moving parts, a high dexterity, typically low friction, large workspace, etc.

On the other hand, they suffer from some drawbacks such as limits in the cable tensions, poor compactness, possible interferences between cables, and vibrations. Also, as a result of the unilateral nature of the cables which can only produce tension forces, redundancy in the actuation is necessary. This means that to completely constrain the MP of an n-DOF cable robot, m>n cables are required. Several researches have shown that using more cables results in larger workspace and generally better performance of the robot.

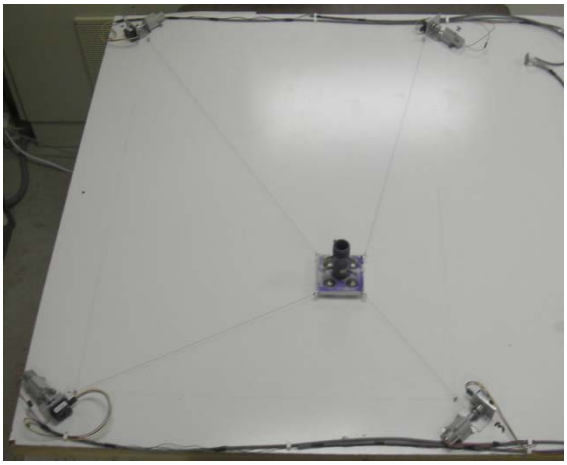

Figure 3 a planar cable robot with four cables

Figure 4 Skycam: a commercialized suspended cable robot

Therefore, in cable robots the number of required actuators is always greater than the number of degrees of freedom (DOF) which increases the cost and complexity of the control equipment. This issue is more critical if the more cables are used in the structure of the robot to obtain better the performance in terms of the size of the wrench-feasible and wrench-closure workspaces (WCW & WFW). Thus, to keep the number of actuators at minimum while the number of cables (and thus the performance of the mechanism) is increased, it was proposed to use cable differentials in the architecture of the cable-driven robots. They are used in different machines and mechanisms to distribute an actuation source to several degrees of freedom. Through some examples found in the literature it was shown that using these systems in the structure of planar cable-driven mechanisms increases their workspaces comparing to the fully-actuated cable robots driven by the same number of actuators. We wish to design and built a small–scale prototype of a cable robot driven by differential mechanisms with a simple planar architecture to evaluate these results in practice.

Main Tasks during the Internship
Mechanical designing and manufacturing a prototype of a planar differentially actuated cable robot:

- Modeling the robot according to the existing schematic and design parameters;
- Providing the drawings for manufacturing the components of the prototype;
- Assembling the parts of the prototype and test it.

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Required Skills for the Internship

- Experience with the following techniques is desirable:
- Kinematics of mechanisms
- Very good CAD skills, CATIA of Inventor preferably
- Design of mechatronic devices (motor drives, gears, microcontroller, etc.)
- Excellent Matlab programming skills
- Excellent writing and speaking communication are mandatory

Location

Main Building

Supervisor

Mr Lionel BIRGLEN, Associate Professor, Department of Mechanical Engineering
http://www.polymtl.ca/recherche/rc/en/professeurs/details.php?NoProf=341&Langue=A

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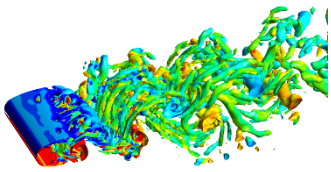
#38: Area of Expertise: Mechanical Engineering

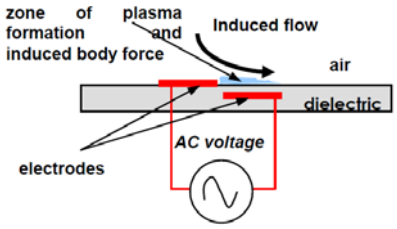
Research Project Title
Fluid-structure Interaction Control and Energy Harvesting

University Cycle
2nd cycle (Master)

Background Information
Fluid-structure interaction (FSI) is a fundamental phenomenon with a wide range of industrial application. In the case of fluidelastic instabilities, eroelastic flutter, the structure subjected to flow can extract energy from flow thus resulting in instability. Vortex-induced vibration (VIV) is another important FSI mechanism. While instabilities are inherently destructive, there are also efficient mechanisms for energy harvesting.



In the proposed project, a CFD analysis will be conducted to estimate the energy that can be extracted from an unstable structure. To enhance the instability, and increase the energy harvested, additional flow instabilities can be triggered. This will be done using plasma actuators. Plasma actuators are surface mounted electrodes which generate flow jets by ionizing the air above the electrodes followed by acceleration by the local electric field. The actuators have fast response time, making them idea for flow control. The actuators can be used to destabilize or stabilize the flow are required provide significant control on energy transfer.



Main Tasks during the Internship
- CFD analysis of flow around a cylinder incorporating plasma actuators for wake control and energy harvesting
- Wind-tunnel tests to investigate plasma actuator performance and energy harvesting

Required Skills for the Internship
- Have taken undergraduate fluid mechanics and if possible some experience with CFD analysis.
- Ability and interest in experimental testing

Location
Main Building

Supervisor
Mr Njuki MUREITHI, Professor, Department of Mechanical Engineering
http://www.polymtl.ca/recherche/rc/en/professeurs/details.php?NoProf=311&Langue=A

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#39: Area of Expertise: Mechanical Engineering

Research Project Title
3D Printing of High-Performance Composites for Aerospace Applications

University Cycle
1st cycle (undergraduate)

Background Information
This internship will be performed at the Laboratory of Multiscale Mechanics (LM2) of Polytechnique Montreal. Some of the projects are realized in collaboration with aerospace companies.

Main Tasks during the Internship
Under the supervision of Prof. Therriault, the intern will assist a current PhD student with the realization of his research project. The LM2 is currently developing new 3D printing methods and various advanced materials with enhanced mechanical, thermal and electrical properties.

Required Skills for the Internship
- Strong Mechanical Engineering or Material Sciences background
- Interest for applied research, 3D printing technologies, CAD
- Familiar with material characterization (e.g., optical microscopy, SEM)
- Good team worker

Location
Bombardier Building

Supervisor
Mr Daniel THERRIAULT, Professor, Department of Aerospace and Mechanical Engineering
http://www.polymtl.ca/recherche/rc/en/professeurs/details.php?NoProf=294&Langue=A
http://www.polymtl.ca/lm2

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#40: Area of Expertise: Physics Engineering and/or Materials Science

Research Project Title
Solution-Processed Metal-Halide Perovskite Lasers

University Cycle
1st cycle (undergraduate), 2nd cycle (Master) or 3rd cycle (Ph.D.)

Background Information
Hybrid and inorganic metal-halide perovskites are fascinating materials with broadly tunable optical properties. For example, by changing their composition, their bandgap can be varied from the visible to the infrared part of the spectrum. The internship will be performed in the Laboratory for Nanostructured and Molecular Photonics, under the supervision of Professor Stéphane Kéna-Cohen, the Canada Research Chair in Hybrid and Molecular Photonics.

Main Tasks during the Internship
The intern will fabricate optically-pumped perovskite lasers emitting in the infrared part of the spectrum based on tin-containing perovskites. These lasers will address a spectral range difficult to address with competing solution-processed material sets. The student will participate in the design, fabrication and characterization of the lasers.

Required Skills for the Internship
- Knowledge of semiconductor physics
- Experience with solution processing of thin films and laser spectroscopy

Location
Main Building and Bombardier Building

Supervisor
Mr Stéphane KÉNA-COHEN, Assistant Professor, Department of Engineering Physics
http://www.polymtl.ca/recherche/rc/en/professeurs/details.php?NoProf=562&Langue=A

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