Air Quality Instrument Package for Unmanned Aerial Vehicle

Laboratory Name: Energy and Aerosols Laboratory
Faculty Supervisor: Steven Rogak
Graduate Student Mentor: Steven Zimmerman

General Area of Research:

Instrumentation, Experimental thermofluids, air quality

The Project:

Drones can allow us to measure emissions from complex sources or in complex spaces that are inaccessible to traditional ground-based instruments. For example, an industrial site with inadequate monitoring could be circled by an instrumented drone to determine the flux of pollutants from the site. This approach could also find applications in smaller communities and in middle and lower income countries where a network of ground-based instruments is prohibitively expensive.

In an ongoing project, which started as an undergraduate thesis, we have developed a method to determine local wind speed and direction from the drone motion and GPS data. In the next step, to be led by the CREATE U student, we will build a compact instrument package and test the whole system in controlled field experiments. We are looking for a student interested in developing their hands-on skills and integrating this with their knowledge of both aerodynamics and instrumentation.

What You Will Do:

You will be selecting, testing and modifying sensor components and combining them in a lightweight package. This will require you to learn about the physical principles of the sensor (two key ones are for methane and particulate matter), and about how sensors communicate with the onboard data logger and telemetry system. You will set up controlled field experiments, such as a small smoke or methane source with known emissions that can then be measured by the drone flights. Reporting and communicating your research is an important part of the experience.

Supervision Received:

We anticipate supervision by the graduate student mentor several times per week. Meetings with Professor Rogak will occur weekly in May and August, but less frequently in June and July when Prof. Rogak expects to be travelling. In addition to the main student mentor, Steve Zimmerman, you would likely work with 2-3 other graduate students working on this general project.

Skills for Success:

You most have demonstrated success and/or enthusiasm, in courses or work placements, in assembling and programming a real-time device such as Arduino or Raspberry Pi with sensors. A strong foundation in engineering science courses will be a real asset in understanding the operating principles of the sensors. The ability to take charge of your own project schedule and move it along is probably the most important skill involved.

Project title: Computational model for heat transfer between cryogenic fluid and a metallic plate

Faculty Supervisor: Jasmin Jelovica, PhD
Graduate Student Mentor: Alireza Babaee, PhD student

General Area of Research:
Computational Mechanics

The Project:
Liquefied Natural Gas (LNG) is nowadays being introduced as a fuel in vehicles because it is cheap and causes fewer emissions than gasoline/diesel. For storage and transportation purposes, LNG must be kept below its boiling point (-161.5 °C at 1 atm). This is a "cryogenic" temperature range, meaning extremely low-temperature. In case of a breach of LNG tanks/pipes, cryogenic liquid is spilled on a surrounding structure, which is at ambient temperature. Consequentially, the structure is subjected to a thermal shock because of the spill. The thermal shock induces very high temperature gradient inside the structure. The structure very quickly warms up the LNG, which starts to evaporate and boil. To assess thermal stress accurately, it is necessary to understand the behavior of LNG and its phase transition. Small/moderate spills are of interest in this project that aims to provide design tools for a new generation of ships for Canadian commercial fleet.

Computational Fluid Dynamics (CFD) is a powerful tool to simulate behavior of fluids and model heat transfer in multi-physics problems. The current project focuses on heat transfer between cryogenic fluid and a plate plus evaporation process within cryogenic fluid. The main goal is to understand and quantify thermal loading acting on the plate, by modeling the fluid evaporation characteristics with CFD and accounting for various modes of heat transfer between cryogenic fluid, plate and surrounding air.

What You Will Do:
1) Survey scientific literature to understand how heat transfers between cryogenic fluid and structure with the possibility to consider Fluid-Structure-Interaction (FSI)
2) Run CFD simulations using Star CCM+ or other commercial CFD packages
3) Validate the CFD solutions with existing literature
4) Discover and explore the physics behind cryogenic thermal loading on the material surface using CFD simulations
5) Modify the simulation to consider different spill scenarios

Supervision Received:
You will discuss with Dr. Jelovica and his research group on weekly basis. You will get detailed instructions in first several weeks, and anytime you need help. You will need to create the models and run initial analyses using your own personal computer. Longer analyses will be run on a local cluster, and you will get help on that.

Skills for Success:
You need to be motivated and a fast learner. Basic knowledge of Heat Transfer and Fluid Mechanics is necessary. Previous knowledge in CFD modeling, FSI and coding/programming would be an asset.

Control-Oriented Modeling for SCR Aftertreatment Systems in Diesel Engines

Laboratory Name: Control Engineering Lab & Clean Energy Research Lab
Faculty Supervisor: Dr. Ryozo Nagamune and Dr. Patrick Kirchen
Graduate Student Mentor: N/A

General Area of Research:

Dynamic Modeling, Internal Combustion Engine, Engine Aftertreatment

The Project:

This project aims at developing a control-oriented state-space model of the Selective Catalytic Reduction (SCR) aftertreatment systems in diesel engines. The model should represent the dynamic behavior of the SCR system from the control input (urea injection) and the exogenous inputs (nitrogen oxides, exhaust gas flow rate and temperature) to the nitrogen oxides emission and the ammonia slip at the downstream of the SCR catalyst. The commercial simulation package GT-Power is used to generate the "experimental" data under various engine operating conditions, and model parameters are selected to explain the data.

The outcome of this project will be used for urea injection controller design to minimize the nitrogen oxides emissions, thereby leading to cleaner diesel engine emissions and contributing to greener environment.

What You Will Do:

The CREATE-U student will develop a tool to simulate diesel engine operations using GT-Power. She/he will obtain the time responses of input-output data of the SCR system by simulations under various engine operating conditions such as engine speed and torque, and build state-space models parameterized by the operating conditions. She/he will validate the constructed model and clarify the limitation of the model.

Supervision Received:

The CREATE-U student will be supervised by Dr. Ryozo Nagamune and Dr. Patrick Kirchen. We will hold 1-hour weekly regular meetings, where the student reports her/his progress and short-term and long-term plans.

Skills for Success:

Experience in modeling of dynamic systems, experience in Matlab/Simulink, interest in engine systems, understanding of state-space models

Project Title: Development of a Metal 3-D Printing System using Direct Laser Deposition

Faculty Supervisor: Xiaoliang Jin, Minkyun Noh, Ryozo Nagamune, Steve Feng

General Area of Research: Manufacturing and Mechatronics

The Project:

Additive manufacturing (also known as 3-D printing) has been the new thrust in the manufacturing of metallic components with complex geometries. Currently, the technology development in laser additive manufacturing has enabled the fabrication of functional components in various key industrial sectors, such as remanufacturing of impeller blades in aerospace engine components, or producing dies and molds with complex internal cooling channels. Figure 1 shows some typical metal parts which are achieved by the additive manufacturing process.

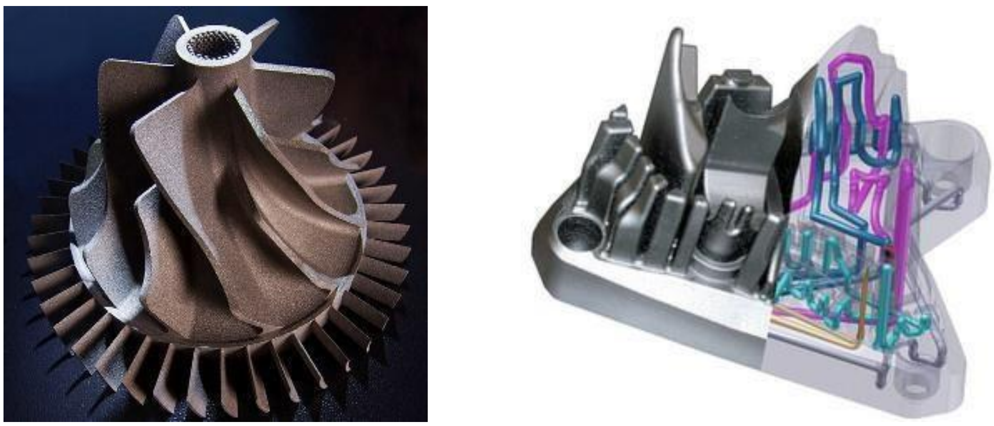


Figure 1 Typical metal parts made by additive manufacturing [1, 2].

This project will focus on system integration to achieve a laboratory-based additive manufacturing system. The system is expected to perform the deposition of metal powders layer-by-layer using a laser beam. The key components currently available at UBC include a 4-axis motion platform, a laser generator, laser beam optics, a deposition head, and a powder feeder. The integration of the mechanical and electrical components and the development of the control system will be performed to enable the functioning of the system.

What You Will Do:

The project will involve the integration of the existing parts to enable the operation of the laser deposition system, and analyze how the process conditions (e.g., laser power, powder feed rate) influence the additive manufacturing performance, including process efficiency and part geometry. The CREATE-U student will design mechanical fixtures to integrate the laser deposition head to the motion platform, and integrate necessary protective components on the machine. The student will also design electric components to instrument and control the sub-systems, such as the laser generator and the powder delivery system. Once the system's hardware components are ready, the student will take training on the laser deposition system, then implement the control of the motion stage and perform the laser printing process. Sample metal components will be fabricated, and the component geometries will be assessed.

Supervision Received:

The student will work with the faculty members in manufacturing area, including Drs. Xiaoliang Jin, Minkyun Noh, Ryozo Nagamune, and Steve Feng. Weekly meetings will be held to discuss the research progresses, and more frequent communications are available upon further appointment.

Skills for Success:

The student should have backgrounds in mechatronics and mechanical design. Hands-on experiences for fabricating mechanical and electric components are preferable.

References:

[1] https://www.mmsonline.com/articles/the-magazine-about-additive-manufacturing-offunctional-parts

[2] https://www.renishaw.com/en/industrial-applications-of-renishaw-metal-additivemanufacturing-technology--15256

Experiments with hollow microneedles on biological tissue

Laboratory Name: Stoeber Lab
Faculty Supervisor: Prof. Boris Stoeber
Graduate Student Mentor: Pranav Shrestha

General Area of Research

Tissue biomechanics, microfluidics, biomedical imaging, fluid/solid mechanics

The Project

Hollow microneedles are biomedical microdevices that target the skin for applications such as drug delivery and bio-sensing (e.g. blood and/or interstitial fluid extraction). Due to their small size (around a millimeter in length and 1/10 of a millimeter in diameter), hollow microneedles improve patient compliance and are less invasive than the conventional hypodermic needles. For optimizing the use of microneedles for injection of drugs (such as vaccines) and for extraction of blood or interstitial fluid (ISF), the mechanics of microneedle insertion into skin and fluid flow through biological tissue needs to be explored further. This study aims to experimentally investigate either 1) the insertion mechanics of hollow microneedles into soft tissue (skin) and artificial skin models; or 2) the fluid transport through biological tissue, such as blood/ISF flow through skin for bio-sensing applications and fluid injection into skin for drug delivery applications. The experimental results will be compared to theoretical models and to other reported experimental results. The findings from such a study can help improve or create new minimally-invasive techniques for drug delivery and bio-sensing.

Tasks to be performed by the student

- Conduct experiments with hollow microneedles using existing experimental setup for insertion/injection/extraction
- Analyze and process sensor/actuator data
- Design and 3D print (or machine) any required modifications to the experimental setup for testing new samples
- Conduct literature review to relate experimental findings to theoretical models
- Prepare skin sample or fabricate artificial skin models

Facilities and team

The experiments will be conducted in AMPEL 146, Advanced Materials Process Engineering Laboratory or PPC 121, Pulp and Paper Centre. The student will work closely with Prof. Boris Stoeber's graduate student, Pranav Shrestha (email: pranav.shrestha@alumni.ubc.ca).

Supervision Received

The regular supervision of the student will be performed by the graduate student mentor. The student will be provided with initial references for literature review, and will be trained on using the experimental setup and the imaging modality (e.g. optical coherence tomography, high speed imaging). The student will get access to the lab and a student office space in Kaiser, which is shared by members of the Stoeber Lab and other research groups. The student will attend group meetings for the Stoeber Lab, which occur approximately once every week.

Skills for Success

- Interest in biomechanics and/or fluid mechanics
- Interest in working in a laboratory setting
- Ability to work under minimal supervision
- Curiosity to learn new concepts/techniques
- Willing to handle biological materials

Options for remote work

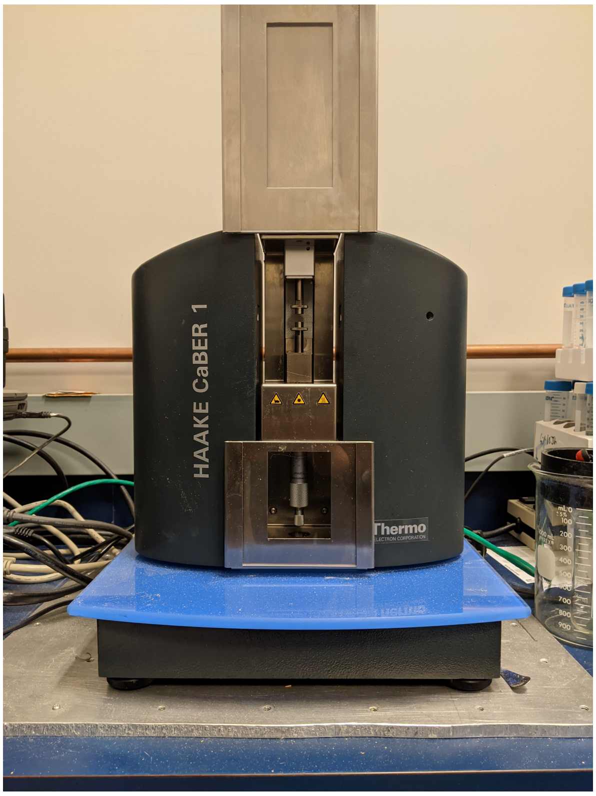
In case of limited access or restrictions to UBC laboratories, the project could be modified to include analysis of previously recorded experimental data, or computational work (e.g. simulation or modelling of mechanics of microneedle insertion or fluid extraction).

Extensional Rheology of Complex Fluids with CABER device

CREATE-U Project

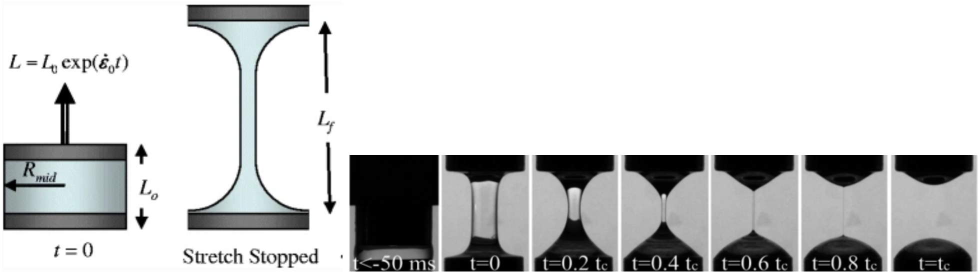
November 20, 2020

Complex fluids are ubiquitous and are critical components of a variety of industrial, geophysical and biological processes. Characterizing the response of such fluids to different perturbations like an imposed stress is critical from a practical and fundamental viewpoint and underlines the scientific discipline of *rheology*. Largely, rheological studies are carried out in a shear rheometer - a device that applies a *shear* deformation on a material. However, many processes are marked by an extension. A helpful way to visualize an extensional deformation is to imagine a drop of honey enclosed between your index finger and thumb and then pulling on it by stretching the fingers apart. Generally, for Non-Newtonian fluids, the resistance (extensional viscosity, η_E) to such 'stretching' deformations is different than that in shear (η_s). Thus, there is a need to study the *extensional rheology* of complex fluids and soft materials. A device used to measure the extensional rheology of complex fluids is a **Capillary Breakup Extensional Rheometer (CABER)**.



The CABER instrument in the Complex Fluids Lab, UBC

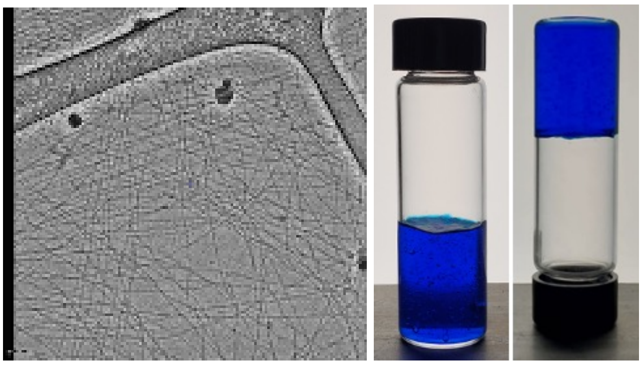
In the CABER, a small amount of material is sandwiched between two parallel plates. The plates are pulled apart, as a thin liquid bridge forms and subsequently begins to thin. By tracking the evolution of the midpoint diameter of this bridge in time and relating it to theory developed for viscoelastic liquids, we can extract η_E. Imaging the capillary thinning process of the bridge and tuning the rate of stretching, allows us to obtain an understanding of how a variety of complex fluids respond to extensional deformations.



Left : Schematic of the process at the heart of the CABER device from Miller et.al, Rheologica Acta, 2009, Right : Typical thinning of the liquid bridge in time from Kim et.al, Korea-Australia Rheology Journal, 2009

Goals

Our primary goal is to use the CABER device to study how gels formed by wormlike micelles respond to extensional deformations. For that purpose, we have to first calibrate the device and it's inbuilt laser that is used for mid-point diameter measurement. Next, we carry bench-marking studies with some typical polymeric suspensions for which measurements of η_E are readily available in scientific literature. Finally, we use prepared samples of wormlike micellar gels to investigate their characteristics when probed under extensional deformations. It's likely that the capillary thinning process in such fluids might not be properly tractable via the CABER's laser. In that case, we intend to construct an imaging set-up to extract details of its thinning dynamics.



Left : Cryo-TEM image of a wormlike micellar gel shows a network of entangled fibre like structures, Right : An upturned vial of a 10 w% gel holds its own weight for many days

Rheology of complex fluids and soft matter is an exciting and vibrant field of research. We are working to build a workable experimental system to probe the extensional dynamics of a unique class of soft materials. We encourage motivated undergraduate students to apply and collaborate with us in this research endeavor. This project has rich learning opportunities and associated students are likely to learn introductory rheological concepts and gain experience in techniques for image processing, data acquisition and analysis.

Eye-Tracked VR Headset

Microelectromechanical Systems Laboratory
Faculty Supervisor: Dr. Mu Chiao
Graduate Student Mentor: Hiroshan Gunawardane

General Area of Research:

Electronics, Virtual Reality, Eye-tracking, Human Machine Interactions, Game Programming

The Project:

This project is focused on developing a new virtual reality (VR) and augmented reality (AR) system for entertainment and medical applications. The main goal of this project is to use human eye movements to reduce cybersickness and eye fatigue during longtime VR/AR applications. You will receive our alpha prototype of new headset and will be working on several aspects mentioned in the following section.

What You Will Do:

In this project you will be optimizing our alpha prototype of the new headset mainly focusing on following aspects,

- *Re-designing and fabricating PCBs (i.e., increase number of layers, reduce noise).*
- *Testing dry electrodes and comparing the performance difference with wet electrodes.*
- *Implementing a real-time EOG filter on the head-set.*
- *Developing a mobile application and generating an interactive game environment.*
- *Fine-tuning Bluetooth connectivity at minimal latency (higher than 60 FPS).*
- *Developing Bluetooth autoconnection between headset and mobile phone.*
- *Developing auto-calibration program for the headset.*
- *Setting up experimentations and running human subjects to measure cyber sickness and eye fatigue.*

You will be working with a multi-disciplinary team form mechanical engineering, psychology, and external partners from the industry.

Supervision Received:

The day-to-day supervision will be carried out by Hiroshan Gunawardane at the MEMS laboratory and you will be meeting Dr. Mu Chiao weekly basis to deliver your progress. In case of unavailability, the skype/zoom discussions will be arranged and clarify any issues related to the project. The student will gain the hands-on experience in circuit designing, fabricating (mechanical and electronics), game developing, human computer interfacing, and running experiments related to human subjects.

In case of university closure due to COVID-19 you will be facilitated to working from home via online.

Skills for Success:

The knowledge in basic programming will be required. Mechatronics specialization is preferred. Previous experience in game development engines such as UNITY or Blender will be advantageous.

Investigating the human brain's response to mechanical trauma

Laboratory Name: Sensing in Biomechanical Processes Lab (SimPL)
Faculty Supervisor: Lyndia Wu
Graduate Student Mentor: Calvin (Zhuhan) Qiao

General Area of Research:

Biomechanical Engineering, Injury Biomechanics

The Project:

Mild traumatic brain injury, commonly known as concussion, is a major public health concern. In sports, falls, and car accidents, blunt impacts on the head can result in brain trauma. It is thought that stresses and strains in the brain are the direct mechanical factors causing brain and sensorimotor dysfunction. However, the exact mechanism is still poorly understood. In this project, we will use experimental and computational methods to determine mechanical inputs to the brain, and correlate with injury outcomes such as common concussion symptoms. A better understanding of this mechanism can lead to more timely diagnosis of injury and design of more effective protective equipment (e.g. helmets).

What You Will Do:

This is a flexible project where, based on the experience level and interests of the student, one or more of the following activities could be discussed:

- *Building/applying physical brain models and acceleration devices to simulate brain mechanical deformations.*
- *Developing or applying computational brain models to simulate brain deformations.*
- *Instrumenting human participants with biomechanical and physiological sensors to measure the input head accelerations and output brain changes.*
- *Analysis of human participant data from sports and other head impacts scenarios.*
- *Developing simulation models/hardware to examine sensorimotor changes after head impacts.*

Supervision Received:

1. *Weekly meetings with Dr. Wu (additional ad hoc meetings can be scheduled as needed); 2. More frequent interactions/consultations with grad student mentor as well as other graduate/undergraduate students in the lab; 3. Weekly lab meetings to communicate research with all members of the group.*

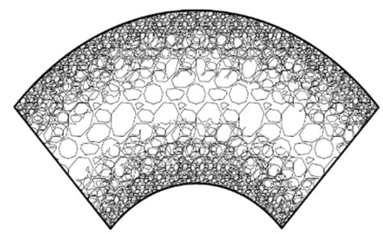
Skills for Success:

- *Basic understanding of solid mechanics, materials, and dynamics (MECH2 level) required*
- *Experience with Matlab, computational modeling software, inertial sensors, and Arduino-type circuits could be assets*

Project title: Mechanics of functionally graded porous beams

Faculty Supervisor: Jasmin Jelovica, PhD
Graduate Student Mentor: Mohammad Keleshteri, PhD candidate

General Area of Research:
Computational Mechanics

The Project:


Porous materials offer exceptional structural properties, the most important being low weight and high stiffness and strength. Nature has figured this out a long time ago by making bones porous. Size of pores in bones is gradually changing through the volume, as a function of loading and support. The goal here is to translate that to everyday devices and structures, making them much more efficient and allowing greater design flexibility by offering wider range of properties than traditional materials. Construction of porous structural elements was not feasible in recent decades, but with progress made in additive manufacturing, they can be used more freely on a larger scale.

Going a step further, porosity can be graded in different directions, making the structure even more efficient. Figure on the top right shows an example where pores are smaller closer to the surface of the curved beam. The intricate web of pores becomes very complex to model explicitly in analysis. Reduced order models based on beams, plates and shells can be used to predict certain types of responses. They have difficulty with predicting local deformation modes and local stress. This project aims to quantify the accuracy of beam models to predict local stress, buckling and vibrations of functionally graded porous beams. Finite element models need to be developed using Abaqus software, and compared with available results based on beam theory. This project is part of a research program that aims to provide design tools and advanced structural solutions for a new generation of ships for Canadian Coast Guard.

What You Will Do:
1) Survey scientific literature to get familiar with porous materials and their structural models
2) Create finite element models of porous beams using Matlab and analyze them using Abaqus software (codes and templates will be provided)
3) Perform stress, buckling and vibrational analysis

Supervision Received:
You will discuss with Dr. Jelovica and his research group on weekly basis. You will get detailed instructions in first several weeks, and anytime you need help. You will need to create the models and run initial analyses using your own personal computer. Longer analyses will be run on a local cluster, and you will get help on that.

Skills for Success:
You need to be motivated and a fast learner. Basic knowledge of programming in Matlab is necessary. Experience with finite element theory and software is beneficial, but not necessary.

Pneumatic Soft Actuators for Medical Applications

Microelectromechanical Systems Laboratory
Faculty Supervisor: Dr. Mu Chiao
Graduate Student Mentor: Hiroshan Gunawardane

General Area of Research:

Soft robotics, Soft actuators, 3D Printing, Robotics manipulators, Surgical robots

The Project:

This project is focused on developing a novel soft actuator (SA) for medical applications such as surgical manipulation. The main goal of this project is to design and develop a novel pneumatic soft actuator that can perform various tasks in confined spaces with minimum energy expenditure. You will be working on different aspects of soft actuator designs and fabrication with our team at MEMS Lab.

What You Will Do:

In this project you will be working on optimizing our new soft pneumatic actuator and you will get hands-on experience in following aspects,

- *3D Printing of the molds of the SAs*
- *Fine tuning, finalizing, and printing structures on our new 3D printer (developed by our capstone team)*
- *Design and development of pneumatic control systems for SAs*
- *Characterization of soft actuators*
- *Interfacing our SAs on robotics systems such as manipulator robots and daVinci robot*
- *Running different experimentations to evaluate the performance of above-mentioned systems*

Supervision Received:

Day-to-day supervision will be carried out by Hiroshan Gunawardane at the MEMS laboratory and you will be meeting Dr. Mu Chiao weekly basis to deliver your progress. In case of unavailability, the skype/zoom discussions will be arranged and clarify any issues related to the project. The student will gain the hands-on experience in designing, simulating, fabricating (mechanical and electronics), and running experiments to characterize soft pneumatic actuators.

In case of university closure due to COVID-19 you will be facilitated to working from home via online.

Skills for Success:

The experience in SOLIDWORKS and finite element analysis packages (not mandatory) will be advantageous.

Augmented Reality-based Guidance System for Efficient Demonstration Distribution

Laboratory Name CARIS
Faculty Supervisor: Machiel Van der Loos
Graduate Student Mentor: Maram Sakr

General Area of Research:

Robotics

The Project:

Robots are increasingly being used in many areas in our daily life, from industrial and social robots to robots used in medicine and space. Thus, it is crucial to have effective methodologies for robot programming and customization. Robot Learning from Demonstration (LfD) is the branch of robotics research that is concerned with programming robots to perform tasks by observing demonstrations from humans without the need for any robot programming experience. It has been shown that robot learning efficiency is significantly affected by the quality of the demonstration data. By having high-quality demonstration data, we accelerate a robot's learning process.

One of the main issues that affect the demonstration's quality is data sparsity. Data sparsity refers to the existence of areas of the task space that have not been demonstrated, which causes poor generalization. To achieve generalizability, it is crucial to consider the diversity and distribution of the demonstrations over the task space. In other words, we want to avoid redundant demonstrations and dense demonstrations in a small area of the task space. Towards achieving this goal, visual guidance will be used to guide the demonstrators for the best demonstration position in the task space. Augmented reality (AR) will be used for visual guidance. Maximizing information entropy is the main criteria for deciding the best demonstration's position in task space.

What You Will Do:

The student will write code for picking the best demonstration position in the task space. Besides, an interface will be designed in unity to be used with Microsoft HoloLens for visual guidance. Afterwards, an experimental protocol will be designed with the mentor's help to show the effectiveness of the provided approach. Finally, data collection from different participants to compare the proposed approach with the other state-of-the-art techniques.

Supervision Received:

This project will be carried out under the supervision of Prof. Mike Van der Loos and a Ph.D. student, Maram Sakr. The supervision will be daily with the mentor while the student will meet the supervisor weekly. In addition, we have a weekly group meeting at which we discuss and present our work, allowing the student to learn more about other work in the lab and seeking help from other lab members if needed.

Skills for Success:

Student should be generally familiar with robot kinematics and programming. Specifically, our system uses ROS. A knowledge of C/C++ or Python will be required. Basic knowledge of Machine Learning will be an asset.

Augmented Reality (Hololens) for Intra-Operative Fluoroscopy

Laboratory Name: Surgical Technologies Lab (VGH)
Faculty Supervisor: Antony Hodgson
Graduate Student Mentor: Matthew Hickey (PhD student)

General Area of Research:

Biomedical Engineering (medical device design)

The Project:

In many orthopedic surgeries, the surgeon relies on a C-arm fluoroscopy machine with the images usually displayed on a bedside monitor. The mental effort that surgeons expend transferring information from the imaging display back to the surgical site can lead to distraction causing errors that could directly influence quality of surgery.

We have developed a Depth Camera Augmented Fluoroscopy (DeCAF) device which uses an Intel RealSense depth camera to provide real-time visualization of the surgical site by overlaying x-ray images from the C-arm onto live video of the patient's surface anatomy. Using geometric data acquired via the depth camera, the device transforms a real-time video feed aligned with the camera coordinate system to a perspective aligned with the x-ray source. In effect, we give the surgeon 'x-ray vision'.

Our lab has also developed a first version of a machine learning technique that uses intraoperative x-rays to determine a C-arm fluoroscope's orientation in the OR relative to a preoperative CT. This technique can then prescribe the translational and rotational changes needed to acquire a desired x-ray. Using a calibration object placed in the surgical space, DeCAF can determine changes to the real-time orientation of the C-arm intraoperatively. This orientation tracking coupled with our labs machine learning algorithms could be a means of reducing surgical time and the number of unnecessary x-ray shots during surgery.

Going forward, we need one or both of the following:

1. Refinement and testing of the machine learning technique for determining the C-arm's orientation relative to a pre-operative CT
2. Design and testing of a means to display this information to the C-arm operator.

What You Will Do:

If you work on Task 1, you will work with some machine-learning techniques to implement our current algorithm, acquire new data from a C-arm machine available in our lab at VGH, and perform some experiments to assess improvements in accuracy. This project will principally involve programming and experimental work rather than design and mechanical work.

If you work on Task 2, your will develop a means of visually communicating the transformations required to acquire the desired x-ray shot to the radiology technologist (radtech) so that they are able to quickly and easily manipulate the C-arm to the desired position. This could be done using visual displays in the operating room or using augmented reality technology such as the **HoloLens** or a new free-standing technology called **The Looking Glass**. There will likely be some prototyping and mechanical design aspects associated with this project.

Supervision Received:

You will do this work in the Surgical Technologies Lab at the Centre for Hip Health and Mobility at VGH. Our group of about 10-12 graduate students has regular weekly meetings and most students work regularly at the lab. Dr. Hodgson works at the lab 3-5 days per week (depending on time of year) and maintains an open-door policy. The graduate student, Matthew Hickey, is a PhD candidate and has experience in related projects – he will be available for consultation on a near-daily basis.

Skills for Success:

Students should be generally familiar with solid modeling tools (eg, Solidworks or similar) and typical engineering programming languages (eg, Matlab or C/C++ or Python or similar). Any experience with machine learning would be an asset for Task 1, while experience in user interface design or visualization or 3D displays would be an asset for Task 2.