Star Tracker Design for Space Object Tracking

Professor: Regina Lee
Lab Website: https://nanosatellite.lab.yorku.ca/
Position Type: Lassonde Undergraduate Research Award (LURA); NSERC Undergraduate Student Research Award (USRA);
Open Positions: 2

Project Description: Main research objective is to design and characterize a camera payload for upcoming CSA Stratospheric balloon mission (2022 launch) to demonstrate Resident Space Object (RSO) detection using a low-resolution camera. LURA or USRA students will assist in the final testing, assembly and operation of the payload for 2022 August launch and prepare for the post-launch data process.

Duties and Responsibilities: Each RA will be responsible for a series of functional test of the payload (long-form functional, thermal cycling, battery life, etc.) to demonstrate the full functionality of the payload. (S)he will also develop an algorithm to process on-orbit data to detect and characterize objects in space. the team will work closely with Magellan (Industry sponsor) and DRDC (government research partners) to further develop infrastructure (a network of small satellites equipped with proposed payload) to provide security and sustainability in operations in space environment.

Work Setting: Project work is carried out on campus, but can be shifted to remote work if necessary

Desired Technical Skills: Programming (Python and MATLAB preferred), working knowledge in embedded system, CAD skills

Desired Course(s): Space, Computer, Electrical or Mechanical

Other Desired Qualifications: N/A

Contact Info: Prof. Regina Lee (REGINAL@yorku.ca)
Atmospheric Modelling - Internal Wave Processes

Professor: Gary Klaassen
Lab Website: https://lassonde.yorku.ca/users/gklaass
Position Type: Lassonde Undergraduate Research Award (LURA); NSERC Undergraduate Student Research Award (USRA);
Open Positions: 1
Project Description: Internal waves generated in the lower atmosphere transport momentum to high altitudes where it is deposited and plays a major role in determining the large-scale circulation of the middle atmosphere. Climate and weather prediction models cannot adequately resolve this process, so they rely on parameterization schemes. This project will investigate wave generation and deposition mechanisms and evaluate the characteristics and performance of different parameterization schemes in order to highlight their strengths and weaknesses, and point the way to better climate models.

Duties and Responsibilities: Computer programming; developing, modifying and running computer models; visualization of model output; literature review; solving mathematical equations; scientific presentations and report writing.

Work Setting: Project work is carried out on campus, but can be shifted to remote work if necessary

Desired Technical Skills: Computer programming experience in Fortran, Matlab or Python is required. Familiarity with atmospheric dynamics or fluid dynamics would be an asset.

Desired Course(s): Completion of MATH 2015, MATH 2271, EECS 1541 or EECS 1540 or EECS 2501 or equivalents. ESSE 1011, ESSE 2012 or other Atmospheric Science courses would assets.

Other Desired Qualifications: TBD

Contact Info: Prof. Gary Klaassen (gklaass@yorku.ca)
Control and Navigation of Autonomous Unmanned Vehicles (AUVs)

Professor: Jinjun Shan  
Lab Website: https://lassonde.yorku.ca/users/jjshan  
Position Type: Lassonde Undergraduate Research Award (LURA); NSERC Undergraduate Student Research Award (USRA);  
Open Positions: 2  
Project Description: Autonomous Unmanned Vehicles (AUVs) are systems that are capable of maneuvering in the air, on the ground, above or under the water. There are a number of potential applications for AUVs in civilian, military and security areas, for example, defense patrol duties, agricultural activities, forest fire monitoring and control, grid monitoring, boarder control, search, surveillance, and rescue. AUVs have great potential benefits to Canada for numerous reasons; many of which are connected with our large uninhabited land, the largest area of forests in the world, and the longest international border in the world. Compared to single AUV, systems with multiple AUVs are more effective in various complicated team tasks due to its inherent advantages, including increased accuracy, robustness, flexibility, lower cost, energy efficiency, and the probability of success. With the recent advancements in AUV hardware and networked system theory, more and more missions require the cooperation of multiple AUVs.  
This project is to develop control and navigation algorithms for autonomous unmanned vehicles. A multi-vehicle test facility has been developed at SDCNLab and will be used to validate the developed algorithms.  
Duties and Responsibilities: The successful student will be working with graduate students and research fellows on (a) programming; (b) hardware development and tests. Through these activities, the student will gain experience in control and navigation system design, hardware and software development, etc. These experiences will be very helpful for the student’s future study and work.  
Work Setting: Project work must be carried out on campus (as permitted by COVID-19 regulations)  
Desired Technical Skills: (1) Good programming skills, MATLAB, C, and Linux; (2) Enrolled in engineering degree; (3) Familiar with ROS; (4) Team player.  
Desired Course(s): Engineering  
Other Desired Qualifications: None  
Contact Info: Prof. Jinjun Shan (jjshan@yorku.ca)
Development of a GPS-reflectometry sensor for soil moisture determination

Professor: Sunil Bisnath
Lab Website: https://gnsslab.lassonde.yorku.ca/

Position Type: Lassonde Undergraduate Research Award (LURA); NSERC Undergraduate Student Research Award (USRA);

Open Positions: 2

Project Description: GPS, and now broadly GNSS (Global Navigation Satellite System), technology is ubiquitous and provides freely-available signals for a multitude of scientific and engineering applications. One scientific application that York’s GNSS Lab has been investigating is the reception of ground-reflected signals for the purpose of inferring properties of the surface, such as surface soil moisture. This science is in its early days but represents the opportunity for very low-cost remote sensing of global soil moisture.

Students will work on the design, development and testing of our next generation Field Programmable Gate Array (FPGA)-based GNSS-reflectometry receiver that is based on a software-defined radio (SDR) design. And also, the design, development and integration of supporting payload components: development board, PCB design and fabrication, computational testing, radio front-end testing and assembly, communications, data storage, housing, etc.

Duties and Responsibilities: Working with a team of PhD and MSc students in the design, development and testing of one or two specific payload components of the GNSS receiver for drone flights. These components include, but are not limited to, signal acquisition and tracking C++ code development, FPGA versions of this code, and payload hardware enclosure design/development/testing. Candidates may also work with graduate students in the collection of drone data in the field, system testing/debugging/tuning, and GNSS signal data analysis. This work is globally leading-edge, so there is the high likelihood of conference and journal paper preparation experience as well.

Work Setting: Project work is carried out on campus, but can be shifted to remote work if necessary

Desired Technical Skills: Experience with SDR coding, FPGA design, and/or embedded systems. Alternatively, experience with space hardware.

Desired Course(s): Current BEng or BSc student in Space Engineering, Electrical Engineering or a related field. Having taken PHYS 3050 “Electronics I”, PHYS 3150 “Electronics II” or equivalent courses. Strong math and coding backgrounds are significant assets.


Contact Info: Prof. Sunil Bisnath (sbisnath@yorku.ca)
Developing Cityscape Semantic Annotation Dataset for AI

Professor: Gunho Sohn
Lab Website: gunhosohn.me
Position Type: Lassonde Undergraduate Research Award (LURA); NSERC Undergraduate Student Research Award (USRA);
Open Positions: 2

Project Description: Nature of the research project: This project aims to generate an innovative benchmark dataset used for training deep learning networks enabling semantic segmentation and object detection using mobile mapping datasets acquired over York University’s Keele Campus. In collaboration with Teledyne Optech, we will expect to acquire about 150 points per square metre and imagery with 10 cm resolution over the entire campus area. With a large amount of incoming data, the LURA trainee will closely work with graduate students and research fellows for conducting a literature review, labelling pipeline design, semantic labelling and quality assurance for AI training. The developed labelling pipeline will be scalable and optimized for training deep learning networks to produce 3D semantic city models at a large scale.

Specific research activities the student be engaged in:
- Conducting literature reviews and comparative analysis of the state-of-the-start cityscape semantic labelling benchmarks
- Post-processing the MMS data, including noise removal and terrain surface reconstruction
- Performing statistical analysis, semantic labelling, data exploration and visualization of MMS data acquired and labelling results
- Developing an efficient and interactive semantic labelling pipeline using GIS data and existing labelling tools

Types of research experience the student will receive:
- Enhancing oral and written communication skills, including conference presentation (the Lassonde Undergraduate Research Conference) and technical report
- Learning the dynamic associated with being part of a research team by attending a lab seminar and a project meeting with industrial collaborators regularly
- Providing hands-on research experience with active/passive sensors, data collection, sensor calibration, deep supervised learning and quality assurance
- Designing and troubleshooting a labelling and pre-/post-data processing experiment
- Applying statistical and error analyses, including through programming

Type of training and support that will be provided to the student in carrying out these research activities:
- The LURA student will work closely with the assigned benchmarking research team, which comprises several graduate students, two postdoctoral fellows and one research associate in the lab. The benchmark research team will provide online training sessions for 1) labelling software tools, 2) Esri’s ArcGIS Pro for GIS data processing, 3)
programming with Python and Matlab.
- Our industrial partners will provide multiple training sessions for introducing the MMS technologies and ArcGIS products through monthly technical workshops.

Qualification: We are looking for a self-motivated and talented science and undergraduate engineering student (2nd year or above) in geomatics engineering, computer science, software engineering or relevant fields, having a strong interest in computer vision, machine learning, remote sensing, photogrammetry and GIS. The LURA applicant must have the following skillsets:
- Strong oral and written communication skills
- Having experience in conducting a literature review
- A basic understanding of data structure, statistical analysis, and data exploration and visualization
- Having a fundamental programming skill in Python or Matlab
- Having experiences in GIS software, computer vision and machine learning (not mandatory)

**Duties and Responsibilities:** The LURA students will conduct the following tasks:
- Preparing a weekly progress report summarizing individual working progress, analyzing potential risks and finding potential solutions to resolve issues
- Attending research meetings with the research team and industrial partners/academic collaborators on a regular basis
- Designing, implementing and validating 3D semantic labelling systems
- Designing, implementing and validating an MLSOps pipeline for optimizing AI networks
- Writing a technical report and a journal to summarize the final outcomes of the project
- Presenting the final project outcomes to a public event including the project’s technical workshop, Lassonde UG Conference and relevant academic workshop/conference

**Work Setting:** Project work is carried out remotely

**Desired Technical Skills:** Programming (Python, Matlab, C++), Open libraries in Computer Vision, Deep Learning, GIS and Photogrammetry

**Desired Course(s):** Relevant course in object oriented programming and data structure; prefer to take one of the following courses (computer vision, machine learning, photogrammetry)

**Other Desired Qualifications:** Certificate or courses in GIS and Remote Sensing, or data base or MLOps

**Contact Info:** Prof. Gunho Sohn (gsohn@yorku.ca)
Developing Visual Annotation Dataset for Autonomous Train

Professor: Gunho Sohn
Lab Website: gunhosohn.me
Position Type: Lassonde Undergraduate Research Award (LURA); NSERC Undergraduate Student Research Award (USRA);
Open Positions: 2

Project Description: Nature of the research project: This project aims to generate an innovative benchmark dataset used for developing deep learning-based computer vision algorithms to control an autonomous train. In collaboration with Thales Canada, we are developing innovative deep learning systems enabling the detection of tracks, obstacles, wayside objects and semantic classes using lidar and cameras mounted on a low-speed train for autonomously controlling it. In recent years, deep learning technology has evolved rapidly and achieved astonishing success in many computer vision tasks. However, the success of developing deep learning technologies is largely dependent on the provision of a massive amount of high-quality training samples. We have acquired a large-scale of visual data from Metrolinx and New York City Transit. In this project, the RAY trainee will closely work with graduate students and research fellows for conducting a literature review, labelling pipeline design, semantic labelling and quality assurance for AI training. The developed labelling pipeline will be scalable and optimized for training deep learning networks to produce cutting-edge semantic labelling benchmark for developing autonomous trains.

Types of research experience the student will receive:
- Enhancing oral and written communication skills, including conference presentation (the Lassonde Undergraduate Research Conference) and technical report
- Learning the dynamic associated with being part of a research team by attending a lab seminar and a project meeting with industrial collaborators regularly
- Providing hands-on research experience with active/passive sensors, data collection, sensor calibration, deep supervised learning and quality assurance
- Designing and troubleshooting a labelling and pre-/post-data processing experiment
- Applying statistical and error analyses, including through programming

Type of training and support that will be provided to the student in carrying out these research activities:
- The RAY student will work closely with the assigned benchmarking research team, which comprises several graduate students, two postdoctoral fellows and one research associate in the lab. The benchmark research team will provide online training sessions for 1) labelling software tools, 2) in-house sensor calibration and alignment tools, 3) programming with Python and Matlab.
- Our industrial partners will provide multiple training sessions for introducing the autonomous train navigation, control and simulation technologies through monthly technical workshops.
Qualification: We are looking for a self-motivated and talented science and undergraduate engineering student (2nd year or above) in geomatics engineering, computer science, software engineering or relevant fields, having a strong interest in computer vision, machine learning, remote sensing, photogrammetry and GIS. The RAY applicant must have the following skillsets:
- Strong oral and written communication skills
- Having experience in conducting a literature review
- A basic understanding of data structure, statistical analysis, and data exploration and visualization
- Having a fundamental programming skill in Python or Matlab
- Having experiences in GIS software, computer vision and machine learning (not mandatory)

**Duties and Responsibilities:** Specific research activities the student be engaged in:
- Conducting literature reviews and comparative analysis of the state-of-the-start cityscape semantic labelling benchmarks
- Post-processing the autonomous visual data, including noise removal, data fusion, and sensor calibration and alignment
- Performing statistical analysis, semantic labelling, data exploration and visualization of autonomous train data acquired and labelling results
- Developing an efficient and interactive semantic labelling pipeline using as-built wayside vectors and existing labelling tools

**Work Setting:** Project work is carried out remotely

**Desired Technical Skills:** Programming skills in Python or Matlab or C++; OpenCV, Point Cloud Library

**Desired Course(s):** Requires to take courses such as object oriented programming and data structure; preferably one of courses in computer vision, machine learning and photogrammetry

**Other Desired Qualifications:** Certificates in GIS and Remote Sensing or database, MLOps

**Contact Info:** Prof. Gunho Sohn (gsohn@yorku.ca)
DEVELOPING MIXED REALITY SANDBOX TO TEACH EARTH SYSTEM ENGINEERING

Professor: Mojgan Jadidi
Lab Website: https://lassonde.yorku.ca/users/mjadidi

Position Type: Lassonde Undergraduate Research Award (LURA); NSERC Undergraduate Student Research Award (USRA);

Open Positions: 3

Project Description: Augmented Reality (AR) and Virtual Reality (VR) technologies, called as Mixed Reality (XR) expand the physical world by adding digital information layers onto what we can see with the naked eye both in an augmented setup and virtual environment. The virtual layers (topography, geology, hydrogeology, and other Earth-related-elements) help students engage with the visualization of 3D problems, something that traditional 2D class material does not readily afford. We adopted an Augmented Reality Sandbox (AR Sandbox) created by UC Davis, which enables students to create 3D topography in real-time using the 3D surface of a physical sandbox, a Microsoft Kinect (depth sensor), and a projector. The AR sandbox allows students to create their desired 3D scene (e.g., mountains, valleys, rivers, and water bodies) within the sandbox, and then a 3D-coloured topographic map and contour lines of the scene are projected, in real-time, onto the sand. In addition, we are extending this system to web-based VR environment at Unity platform, where we developed a virtual sandbox (replica of AR sandbox). The main goal of this project is to embed such technologies and enhance our students' experiential education from first through to fourth year courses across Lassonde (e.g., common ESSE1012 to ESSE/CIVL programs). We are aiming to study the student satisfaction and measure students' learning and the role this system with students' success. Therefore, this came to our attention to revamp our student experience at Lassonde and embed such an XRS sandbox into a stream of courses. To do so we are seeking motivated and passionate undergraduate students to work on three pillars of this project during summer:

Student 1: Game Developer – able to program at Unity platform, able to devise scenario and turn them to a series of game (Computer Graphics or Software Engineering student)

Student 2: Develop Use case scenario for Civil courses (Civil Student upper year student)

Student 3: Expanding AR system, improving pipeline to Unity System (Geomatics, Space, or Software Engineering Student)

Duties and Responsibilities:
Student 1: Game Developer – programming at Unity platform, able to devise scenario and turn them to a series of game activities, technical report, and presentation
Student 2: Develop a series of Use case scenario for Civil courses and work with game developer for testing the Software, prepare user experience survey and analyse data, technical report, and presentation
Student 3: Expanding AR system, improving pipeline to XR Unity System, working with two other team members, technical report, and presentation

**Work Setting:** Preferred in person but flexible

**Desired Technical Skills:**
Student 1: Game Developer – familiar with Unity platform and programming, Understand Human-cantered design approach, able to devise scenario and turn them to a series of game
Student 2: Have strong knowledge of upper year civil Hydrology, water resource management, geology, and geotechnical courses
Student 3: Python programming, hands-on experience with AR sandbox, ability to work in Linux environment, ability to prepare, clean and process point clouds, experience with sensor integration

**Desired Course(s):**
Student 1: Game Developer – Computer Graphics, Digital Media, or Software Engineering student
Student 2: Civil Engineering
Student 3: Geomatics, Space, or Software Engineering Student

**Other Desired Qualifications:** n/a

**Contact Info:** Prof. Mojgan A. Jadidi (mjaddi@yorku.ca)