Autonomous Systems Lab (ASL) M.Eng and Undergraduate Project Openings for Spring 2014

The Autonomous Systems Lab seeks a small group of students (undergrad and/or MEng) across different departments to work with our PhD students on robotics applications and research. Details on the project descriptions, application process, and additional notes are given below.

Segway RMP50/50XL outdoor robot fleet, equipped with Septentrio GPS, 180 deg FOV SICK and 270 deg FOV Hokuyo Lidar, Mimo touchscreen interfaces, 3x Firefly Cameras, onboard IMU, mobile WiFi, custom electronics and mounting hardware.

Notes:

-Undergraduate students are expected to sign up for 3-4 credits of (…ECE/MAE/CS Independent study courses) during the semester, and thus commit at least 9-12 hours per week in the ASL. A commitment of two semesters or a summer and a semester is desired.

-M.Eng students are expected to sign up for 3-4 credits of (…ECE/MAE/CS M.Eng Project Courses) during the semester, and thus commit at least 12 hours per week in the ASL. Unless student is graduating in May 2014, M.Eng projects are expected to continue into the summer or fall semester.

How to apply:

1. Go to cornell-asl.org and download an application form from the front page
2. Scan and e-mail your **completed application and your resume/CV** with the subject line : "[Spring 2014 ASL application] <Your Name>, Project <Project Number> ," where <Your Name> is your name and <Project Number> is the number of the project listed below. Please send your application and resume/CV to one of the following people:

   Professor Mark Campbell, mc288@cornell.edu
   Mark McClelland, mjm496@cornell.edu
   Alexander Ivanov, aii4@cornell.edu

Specific Projects:

1. **1 MAE student:** mechanical design, fabrication and testing for outdoor Segway robots

   Description: Student will work with another member of the lab to design, machine, build, test, and document water-resistant enclosures for long-term outdoor operations. Machining of enclosures and fabrication of vibration/shock isolation mounts for sensitive electronics, and modular aluminum frames will be required. Subsequent semesters will shift towards independent assignments in mechanical design.

   Who should apply: Students at a minimum must have successfully completed MAE 2250 Mechanical Synthesis or an equivalent shop/design course. Other mechanical design and machining experience beyond MAE 2250 is desirable, but not strictly necessary. Student must be willing to spend time in the machine shop during the semester. *Freshmen-junior undergrads are especially encouraged to apply, as are experienced seniors planning to stay for M.Eng.*

2. **1 ECE/MAE student:** micro-controller based sensor network for outdoor Segway robots

   Description: Students validate and robustly test a new Rasberry-Pi-based micro-controller board for accurately synchronizing multiple sensor data streams (LIDAR, GPS, IMU, odometry) on our outdoor Segway robots (pictured above). Student will also be responsible for maintaining, de-bugging, and documenting various other electrical components for the outdoor Segways and other robots/equipment in our lab.

   Who should apply: Students who have experience with micro-controllers and circuit design/fabrication at the level of MAE 3780 Mechatronics, ECE 3140 Embedded Systems, ECE 4760 Digital Systems Design, or equivalent courses. Other electronics and design experience beyond coursework is highly desirable, but not strictly necessary. Student must be comfortable with programming in C or C++, perform extensive hardware tests, and deliver thorough documentation.

3. **1 CS/ECE student:** simulation system for mobile robotics

   Description: Student will design and program realistic components for a simulation environment. This includes physics and design of realistic Segway simulated robots, as well as sensors (LIDAR, IMU, odometry), and generation of realistic outdoor terrain.

   Who should apply: Students should be comfortable with programming in C# or similar/related languages (especially Java or C++) and should have successfully completed at least 1 course emphasizing programming through practical projects/labs (e.g. MAE 4180 Autonomous Mobile Robots, CS 4758 Robot Learning, CS 4760 Computer Vision, or similar MAE, CS, or ECE courses). Other programming and software development experience beyond coursework is highly desirable.

4. **1 CS/ECE student:** visual odometry for robotic navigation

Description: A student is expected to determine an appropriate, robust, stereo visual odometry system from existing open source code. The system should then be tested on our mobile platforms to determine performance on the existing cameras and computers. Final testing should be a demonstration of functional system in lab environment, or small outdoor space, along with evaluation of what needs to be done in order to scale up to outdoor navigation.

Who should apply: Students should be comfortable with programming in C# or similar/related languages (especially Java or C++) and should have successfully completed at least 1 course emphasizing programming through practical projects/labs (e.g. MAE 4180 Autonomous Mobile Robots, CS 4758 Robot Learning, CS 4760 Computer Vision, or similar MAE, CS, or ECE courses). Other programming and software development experience beyond coursework is highly desirable.

5. **1 ECE/MAE students:** Kinect Mapping

Description: Students implement a highh accuracy 3D maping algorithum, and collect data on indoor areas. This project will use a Microsoft Kinect on to generate point cloud maps of Upson and Rhodes, then extract geometry and build a compact map

Who should apply: Students should be comfortable with programming in C++ or similar/related languages and should have successfully completed at least 1 course emphasizing programming through practical projects/labs (e.g. MAE 4180 Autonomous Mobile Robots, CS 4758 Robot Learning, CS 4760 Computer Vision, or similar MAE, CS, or ECE courses). Other programming and software development experience beyond coursework is highly desirable.

6. **1 ECE/CS student:** Visual Object Detection

Description: This project will examine advancing the computer vision capabilities we have in the lab. Currently, we can use our camera system to detect humans using Histogram of Oriented Gradients descriptors with a Support Vector Machine and a sliding window detector. This project entails some or all of the following, based on the student's capabilities and interests:

- Tightening up the formal evaluation tools and datasets used to evaluate the performance of our object detectors
- Evaluating the current implementation of detecting people from camera images on the segway robots
- Constructing a dataset of images of the segway robots and cars, and using these to train a new HOG detector for both
- Evaluating the new segway robot detector and car detector with the evaluation tools mentioned previously
- Integration with the newer CameraServer 2.0 as appropriate
- Performing experiments and analysis to find the noise characteristics for the positions of people in [x,y,z] based on their bounding box in the image

- Working with the grad student to implement and train a newer, better object detector based on a different computer vision algorithm setup

Who should apply: Students should be comfortable with programming in C# or similar/related languages (especially Java or C++) and should have successfully completed at least 1 course emphasizing programming through practical projects/labs (e.g. MAE 4180 Autonomous Mobile Robots, CS 4758 Robot Learning, CS 4760 Computer Vision, or similar MAE, CS, or ECE courses). Other programming and software development experience beyond coursework is highly desirable.

7. **1 ECE/CS student:** Robust Outdoor Localization
   Description: This project will focus on the creation of a robust outdoor localization algorithm. This algorithm should use known theoretical robot localization filters and implement automated initialization procedures and logic. The final goal of this project is to enable a mobile platform to be placed outdoors in a mapped environment and be able to autonomously follow a user defined path with absolutely no human input. The algorithm should be robust and thoroughly field tested in a variety of outdoor environments.

   Who should apply: Student's knowledgeable in linear and nonlinear stochastic filtering such as Kalman filters, particle filters as well as having some familiarity with feature localization (Simultaneous Localization and Mapping) are highly encouraged to apply. Students should be comfortable with programming in C# or similar/related languages (especially Java or C++) and should have successfully completed at least 1 course emphasizing programming through practical projects/labs (e.g. MAE 4180 Autonomous Mobile Robots, CS 4758 Robot Learning, CS 4760 Computer Vision, or similar MAE, CS, or ECE courses). Other programming and software development experience beyond coursework is highly desirable.