

## Autonomous Systems Lab (ASL) M.Eng and Undergraduate Project Openings for Fall 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 January 2015, M.Eng projects are expected to continue into the Spring 2015 semester.

### How to apply:

1. Go to [cornell-asl.org](http://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 :  
"[Fall 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](mailto:mc288@cornell.edu)  
Alex Ivanov, [aii4@cornell.edu](mailto:aii4@cornell.edu)

## Specific Projects:

1. **Re-entrant SLAM: 2 Undergraduate or 1 MEng MAE/CS student:** Object-oriented programming experience necessary. Knowledge of robotic navigation, and SLAM is preferred

**Description:** This project is geared toward the development of a re-entrant Simultaneous Localization And Mapping (SLAM) algorithm. This would enable robots to successfully recognize previously known areas while exploring a potentially unknown environment.

**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). Having taken MAE4180/CS358 will be of great use in this project but is not strictly necessary. Junior or senior students are encouraged to apply.

2. **Human-Robot English Communication: 1 CS/ECE student:** Object-oriented programming experience necessary. Interests in Bayesian data analysis, natural language processing, machine learning, artificial intelligence, or networking is a plus.

**Description:** This project focuses on development of GUI including Twitter-style interfaces for our Human-Robot Information Fusion (Husion) and Robot Opinion (ROpinion) libraries. The goal is to enable information sharing between humans and robots via structured English for search and rescue applications. Depending on the student's background, the project may include development of Amazon Mechanical Turk crowdsourcing applications to facilitate data collection for our research.

**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. Other programming and software development experience beyond coursework is highly desirable. In addition, knowledge of Bayesian data analysis, natural language processing, machine learning, artificial intelligence, or networking will be extremely useful when working with our Human-Robot Information Fusion (Husion) and Robot Opinion (ROpinion) libraries.

3. **Segway Case & Wiring Fabrication: 1 MAE student:** Machine shop certification required.

**Description:** Student manufacture custom designed cases and wiring for our Segway RMP50 platforms. This includes the machining of new parts as well as utilizing a liquid-plastic molding process.

**Who should apply:** Freshmen and Sophomore students are encouraged to apply. This project is meant as a gateway to more demanding mechanical design projects. Those wishing to gain more

machining and fabrication experience, familiarize themselves with ASL, and are looking for future mechanical design projects should apply.

4. **Implementation of Robotic Planners : 1 CS/ECE student:** Object-oriented programming experience necessary. Knowledge of robotic navigation preferred

**Description:** Student will implement known robotic planners. These included algorithms such as the Rapidly-exploring Random Tree (RRT), Probabilistic RoadMap (PRM) and others.

**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. Other programming and software development experience beyond coursework is highly desirable.

5. **Robust-Outdoor Localization: 1 ECE/MAE student:** Object-oriented programming experience necessary. Knowledge of micro-controllers preferred

**Description:** Students will design discrete logic to help autonomous robots maintain and correct their estimated position outdoors. This project will use previously developed outdoor pose estimators in combination with pose recovery methods. Finally students will analyze the performance of on-board magnetometers to be used for outdoor pose estimation.

**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. In addition knowledge of micro-controller interfacing will be useful when working with magnetometers.

6. **Segway Feedback Control 1 MEng student:** Knowledge of control systems is required (or concurrent enrollment). Intermediate dynamics is preferred.

**Description:** Student will design and program a feedback controller for our Segway RMP50 platforms. This project will include a system identification portion and accurate dynamics modeling for our current system.

**Who should apply:** MEng students looking for a systems and control project should apply. Knowledge of basic feedback controller design is essential. Multi-variable control and MPC design will be a plus. Knowledge of system identification will be of great use because the input-output dynamics of our platform are currently unknown.

7. **Segway Human-Robot Interaction (HRI) Mission: 1-2 MAE/CS students:** object-oriented programming experience necessary. Familiarity with robot path and motion planning strongly preferred.

**Description:** Student or group will design, implement, and test a program capable of performing elementary human-robot interaction with the segways robots, in a fully autonomous manner.

Involves traversing an area with people, detecting pedestrians, and briefly conversing with interested humans.

**Who should apply:** Junior or Senior MAE or CS students comfortable using C++, C#, Java, python, or any other equivalent programming language, having taken at least one course using the like. Must also be familiar with programming robotic tasks, such as current or previous enrollment in a course like Mechatronics, Autonomous Mobile Robots, Robot Learning, etc.

8. **LIDAR Pedestrian Detection: 1 CS student:** Prior programming experience and experience in machine learning required. Confidence in performing C++ programming strongly preferred.

**Description:** Student will work with grad student supervisor to design, implement, and evaluate a real-time object detector for detecting pedestrians in 2D lidar scans. Involves gathering experimental data, implementing a few different binary classifier methods, training, and evaluating the detector, and integrating it into our in-house software framework.

**Who should apply:** Junior or senior CS undergraduates with experience with machine learning methods, such as having taken CS4780 or equivalent. Other majors would be fine as long as they meet the other requirements. Must be able to program in C++.

9. **Segway Stereo-Vision and Tracking: 1 MAE/CS student:** Prior experience in computer vision and C++ required. Familiarity with estimation or filtering a plus.

**Description:** Student will use openCV and our current stereo vision framework to track a small number of visible pedestrians. This will involve further integration work with our software framework, as well as implementing new software components and testing them with experiments.

**Who should apply:** MAE or CS students with experience in computer vision, especially 3D operations (for example, work with Kinect, stereo vision, visual odometry, etc.) and openCV. Experience with estimation methods like Kalman filtering is a plus. Must be able to program in C++.