

EECS 397/600 Special Topics: Software Development for the DARPA Robotics Challenge

Fall 2014

Tuesdays, 6:00-8:30 pm, Glennan 313

Instructor: Prof. Wyatt Newman, Glennan 516, 216-368-6432, wsn@case.edu

Text: *Learning ROS for Robotics Programming*, Aaron Martinez, PACKT publishing (available on Amazon), plus instructor's notes to be posted on Blackboard.

Description: The DARPA Robotics Challenge (<http://www.theroboticschallenge.org/>) was designed to spur the rapid development of more capable autonomous and semi-autonomous robots. The final competition will be held in California in June, 2015. Challenges include: driving a vehicle, clearing rubble, opening and passing through doors, climbing ladders, using power tools, and turning



Figure 2: Atlas climbing a block pile



Figure 1: Atlas manipulating an egg

valves.

CWRU has been participating in this competition in collaboration with Team HKU at the University of Hong Kong using an “Atlas” robot from Boston Dynamics (see [wikipedia.org/wiki/Atlas_\(robot\)](http://wikipedia.org/wiki/Atlas_(robot))).

In this class, we will take a hands-on approach to the development of new skills for the humanoid robot “Atlas”, with the objective of creating faster, more competent and more robust task executions. Software development will be in C++ using ROS (Robot Operating System, <http://www.ros.org/>). Weekly assignment solutions will be tested and demonstrated on the “drcsim” simulator of Atlas (see: <http://gazebosim.org/wiki/DRC>). Solutions validated in simulation will be tested on “Atlas” remotely in Hong Kong via a remote Operator Control Station at Case.

Multiple development teams will be formed, nominally comprised of 1 graduate student and 3 undergrads each. The graduate students will be expected to take a leadership role and to monitor and be prepared to report on and demonstrate progress at class meetings. Team leaders should assure that each team member is contributing successfully in their key area.

Students taking this course should be prepared to conduct their remote tests late evenings (nominally, 10pm-midnight, up to 1x/week) to accommodate the 12-hour time zone difference with Hong Kong. Students must have good software-development skills; C++ will be used (but may be learned during the course).

Schedule:

Material will be introduced in coordination with a sequence of assignments that build on each other. The problem sets will expose all students to:

- Programming in ROS
- 3-D point-cloud image interpretation via Point-Cloud Library (PCL)
- Coordinate-frame transforms
- Kinematics of manipulation and manipulation planning
- Hand/eye coordination
- Bi-pedal locomotion planning
- Design of human/machine interfaces (HMI) for remote, supervisory control

Grading: Grading will be based on homeworks, reports, presentations, demonstrations, and *partner evaluations*.