

## EECS 376/476: Mobile Robotics

Spring 2015  
Wyatt Newman

**Instructor:** Prof. Wyatt Newman, Glennan 516, 216-368-6432, [wsn@case.edu](mailto:wsn@case.edu);

Office Hours: Tues/Thurs 4:00-5:00

**Teaching Assistant:** Luc Bettaieb, [luc.bettaieb@gmail.com](mailto:luc.bettaieb@gmail.com) Please let both me and Luc know of any hardware problems that develop with the robot(s).

**Text:** (recommended) Principles of Robot Motion by Choset, Lynch, Hutchinson, et al., MITPress.

See also: A Gentle Introduction to ROS, J.M. O’Kane, <http://www.cse.sc.edu/~jokane/agitr/> (free download).

See also: instructor’s notes to be posted on Blackboard.

**Description:** In this class, we will take a hands-on approach to the creation of intelligent mobile robots. The goal of the course is to learn modern methods for building up robot capabilities using the Robot Operating System (ROS). Through a sequence of assignments, we will learn how to write software to control both simulated and physical robots. Material will include: interfacing software to robot I/O; timing and steering algorithms; path specification and path planning; odometry and localization; obstacle detection and avoidance; use of laser ranging and 3-D point-cloud processing; development of graphical interfaces for supervisory robot control; object recognition and localization from point-cloud data; and robot arm kinematic planning and control. By the end of the course, you should be able to command a mobile robot to “fetch” an object of interest and have the robot successfully navigate, perceive the object, plan and execute grasp, and return with the object.

Experimental (hardware) assignments will be done in teams in the “mobile robotics” lab in Glennan 210.

Material will be introduced in coordination with a sequence of assignments that build on each other. Most simulation assignments will be individual efforts, but physical demonstrations with a mobile robot will be group efforts. Teams will integrate ROS “nodes” composed by team members resulting in physical demonstrations of increasing sophistication.

The first half of the course will cover locomotion, culminating in an integrated demo just prior to Spring break, together with a team mid-term report.

The second half of the class will focus on robot-arm control and sensor-based manipulation. The final demonstration will combine navigation and manipulation to perform “fetching.” There will be a final report (1 report per team) and a final demonstration (1 per team).

**Schedule:**

Week 1: Introduction to ROS and planar mobile-robot motion control; simulation assignment.

Week 2: Speed profiling/trajectory generation, using ROS simulation and visualization

Week 3: Physical robot control; open-loop motion control of “Jinx”

Week 4: Graceful recovery from E-stop (simulation and physical)

Week 5: LIDAR-based reflexive halt and graceful recovery

Week 6: Steering with localization feedback

Week 7: Wall following

Week 8: Demo and mid-term report (1 per team) before Spring Break. Robot moves through a hallway cluttered with obstacles, navigating successfully from start to goal.

Week 9: Spring break

Week 10: Arm control: simple joint control (simulation)

Week 11: Arm control on “Abby” w/ ABB arm on mobile base

Week 12: Inverse kinematics and trajectory generation

Week 13: Human interface: interaction with point clouds inducing arm motion to selected goal.

Week 14: Object perception and grasp planning and execution

Week 15: Combined locomotion/manipulation for “fetch” behavior. Preliminary final demos. Robot plans and executes motion to an approximate pick-up area, perceives an object of interest, plans and executes arm motion and grasp, and returns to home with the acquired object.

April 30, 12:30-3:30: final exam = final demos and final report deadline.

**Laboratory:** The dominant part of this class is performed in the mobile-robotics lab in Glennan 210. We will be using two of our research mobile robots, “Jinx” and “Abby.” Three simulation stations will also be available.

**Grading:** Grading will be based on homeworks, reports, presentations, demonstrations, and partner evaluations. Homeworks (typically involving simulations) will be submitted individually. Students are encouraged to get (and share) advice within their teams, but each individual should write their own code and submit their own solutions. All physical robot demonstrations will be done as teams.

There are two major reports: the mid-term report and the final report (one report per team).

The pace of the course is fast, and the lab work is demanding. It is my hope and expectation that everyone contributes significantly and that all students are rewarded with a high grade.