Northeastern University

EECE5554: Robotics Sensing and Navigation Section 02 CRN 20685 Fall 22

M, W, Th, 4:35-5:40 PM **215 Shillman Hall**

This course examines the actual sensors and mathematical techniques for robotic sensing and navigation with a focus on sensors such as cameras, sonars, and laser scanners. These are used in association with techniques and algorithms for dead reckoning and visual inertial odometry in conjunction with GPS and inertial measurement units. Covers Kalman filters and particle filters as applied to the SLAM problem. A large component of the class involves programming in both the ROS and LCM environments with real field robotics sensor data sets. Labs incorporate real field sensors and platforms. Culminates with both an individual design project and a team-based final project of considerable complexity.

Prerequisite(s): ((MATH 3081 with a minimum grade of D- or EECE 3468 with a minimum grade of D-); (EECE 2160 with a minimum grade of D- or EECE 2210 with a minimum grade of D-)) or graduate program admission

Instructor:

Kris DORSEY, PhD
Associate Professor, Electrical and Computer Engineering and PTMRS
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Office Hours & HCAs: TBA on Piazza

Course readings: As posted to Piazza

Email and Piazza Information:

We'll be conducting class-related discussions and questions through Piazza. Asking questions and carrying out class discussion on Piazza (rather than via emails) lets all instructors, TAs, and your classmates see and answer the questions-- you will get faster replies! Please ask questions when you're struggling to understand a concept—you can even do so anonymously to your classmates. Only I and the other instructors will be able to see your name.
Link to Piazza: piazza.com/northeastern/fall2022/eece5554s02

For questions that should go directly to the course instructor, please email. If it is a question that I believe another student in the course may ask, I will direct you to Piazza. I strive to answer all emails within 24 business hours (e.g., emails sent at 4 PM Friday will be answered by 4 PM on Monday).

COURSE POLICIES

Academic integrity: A commitment to the principles of academic integrity is essential to the mission of Northeastern University. The promotion of independent and original scholarship ensures that students derive the most from their

educational experience and their pursuit of knowledge. Academic dishonesty violates the most fundamental values of an intellectual community and undermines the achievements of the entire University. Northeastern University (and the instructional staff of this course) expect students to complete all examinations, tests, papers, creative projects, and assignments of any kind according to the highest ethical standards, as set forth either explicitly or implicitly in this Code or by the direction of instructors. http://www.northeastern.edu/osccr/academic-integrity-policy/

Policies relevant to each assessment will be listed on the assessment

Academic accommodations:

Northeastern University and the Disability Resource Center (DRC) are committed to providing disability services that enable students who qualify under Section 504 of the Rehabilitation Act and the Americans with Disabilities Act Amendments Act (ADAAA) to participate fully in the activities of the university.

I strive to make the class as accessible as possible. If you have documentation on file with the DRC and you believe those accommodations apply to this course, please email to set up a short meeting. We can discuss course policies and assignments and make sure that your accommodations are being met.

If you feel you need academic accommodations but do not have appropriate documentation on file with the DRC, please check out this resource: http://www.northeastern.edu/drc/getting-started- with-the-drc/

Title IX:

Title IX of the Education Amendments of 1972 protects individuals from sex or gender-based discrimination, including discrimination based on gender-identity, in educational programs and activities that receive federal financial assistance. Northeastern's Title IX Policy prohibits Prohibited Offenses, which are defined as sexual harassment, sexual assault, relationship or domestic violence, and stalking. The Title IX Policy applies to the entire community, including male, female, transgender students, faculty and staff. In case of an emergency, please call 911. Please visit www.northeastern.edu/titleix for a complete list of reporting options and resources both on-and off-campus

I will seek to keep information shared with me as private as possible, but as a professor I am obligated to report any situations relating to sexual

misconduct or harassment that I become aware of to the Title IX office, which may result in the office contacting you to provide you with resources and ask for further information.

Missing Class

You are the best judge of whether you are well enough to attend class. If you are feeling unwell and do not plan to attend, y*ou do not need to send me an explanation email.*
If you know in advance that you will miss a class meeting, I expect that you will submit any relevant assignment on time.

Late Policy

Scores on late assignments will be calculated using the following formula in Python: finalScore = onTimeScore*(1- (hrsLate//24)/10)

Assessments

60% PA/Labs (Individual with some group data collection)
15% Systems Design Exercise (Individual)
25% Final Project (Team)

If there are any discrepancies between the due dates on this syllabus and the due dates on Piazza, the due date on Piazza will be the most up-to-date/correct one.

Date	Topics	Assignments Due
09/07	Introduction to Robotics/ What is a robot Labs, Projects, Readings, Guidelines for programming **PA0: Ubuntu and Gitlab Introduction**	
09/08	Eliza Demo, Failure Analysis, Trolley Switching Problem Introduction to Publish-Subscribe Software Architectures-ROS **PA1: ROS Introduction**	PA 0: Gitlab account and install Ubuntu
09/12	Map Projections, Universal Transverse Mercator	
09/14	Acoustic Navigation Linear Algebra Review	
09/15	GPS systems Introduction to sensors, RS232, UDP, TCP/IP, serial sensor simulator **Lab 1: GPS Introduction**	PA 1: ROS Installation and tutorials
09/19	RTK GPS systems and April Tags Signal Processing Review – Convolution, Fourier Transform in 1D and 2D	
09/21	System Design Glider and Mechanical Design **Lab 6: Mechanical Design Introduction**	
09/22	CAD Design Tutorial **Lab 2: RTK GPS Introduction**	Lab 1: GPS
09/26	IMUs Time measurement, Allan Deviation 3d Transforms	
09/28	IMUs 1	

09/29	**Lab 3: IMU Allan Deviation Introduction**	Lab 2: RTK GPS
10/03	IMUs 2	
10/05	Batteries and Power Design	
10/06	**Lab 4: IMU Dead Reckoning Introduction**	Lab 3: IMU Allan Dev
10/10	No class	
10/12	Power Design AUV	
10/13	Sensing with Cameras - Homographies	Lab 4: Dead Reckoning
10/17	Sensing with Cameras- Feature Detection, Stereo	
10/19	Stereo Example	
10/20	Sensing with Cameras – Calibration	
10/24	Sensing with Cameras – Mosaicing	
10/26	Systems Design – Jetyak, DJI	
10/27	**Lab 5: Camera Mosaic Introduction**	
10/31	Individual Project Discussion	
11/02	Laser Scanners ICP	
11/03	Multibeam Systems	Lab 5: Camera Mosaic
11/07	SLAM 1- Bayes Filters Final Project Discussions	Individual Project (1st pass)
11/09	Probability and Random Variables Review	
11/10	SLAM 2 - Kalman Filtering	Lab 6: Housing Design
11/14	SLAM 3 - 1D and 2D SLAM	
11/16	SLAM 4 - Particle Filtering	
11/17	Inter Sensor Calibration	Indiv. Project (5 Slides)
11/21	Mission Planning	
11/23	No class	
11/24	No class	
11/28	Jetyak end-to-end System SW/HW	
11/30	Project Presentations	
12/01	Project Presentations	
12/05	Project Presentations	
12/07	Project Presentations	
12/17	Final Project documents and all other coursework due	