UNIVERSITY of HOUSTON | ECE

ECE 5397/6397: Robotics & ROS

Location: Class: TBD in TBD
Office hours: 1:00-2:30pm, Mon & Weds. in N386, or by appointment
Instructor: Dr. Aaron T. Becker, email: atbecker@uh.edu, office: (713) 743-6671, cell (217) 722-2058

Teaching Assistant: TBD

Course Description:
ROS (Robot Operating System) is rapidly becoming a de facto standard for writing interoperable and reusable robot software. This class is an introduction to ROS.
After completing this course, you should be able to:
1. Select and implement the appropriate ROS components for a robotics problem
2. Apply algorithms for robotic perception, planning, navigation, localization, and manipulation.
3. Implement and use algorithms for controlling mobile robots.

Final Class Project: Students will form 2 to 4-person teams. Each team will program a robot to perform one of the tasks in our textbook or from a list of research goals form a list the instructors will provide the third week of class. Competitive grading will be used. The final project must have a deliverable: 3D designs to thingiverse.com, code to github.com or Matlab central, and a 5-minute (or less) video posted to YouTube.

Prerequisites: MATH 2433, MATH 3321, and senior standing in major.

Required: students

REQUIRED Textbooks:
Jason M. O'Kane, A Gentle Introduction to ROS, independently published, Updated on 2016-09-06 to version 2.1.3. (Electronic copies freely available from https://www.cse.sc.edu/~jokane/agitr/)

And
Programming Robots with ROS: A Practical Introduction to the Robot Operating System ($40).
http://shop.oreilly.com/product/0636920024736.do

Suggested Textbook
ROS Robotics By Example - Second Edition: Learning to control wheeled, limbed, and flying robots using ROS Kinetic Kame Paperback – November 30, 2017
by Carol Fairchild (Author), Dr. Thomas L. Harman (Author)

Grading: Grades will be determined on the basis of exams, quizzes, attendance, and submitted homework grades with the following **approximate** weights. The actual weights will be fixed at the end of the semester. We will have low-stake quizzes to encourage reading the assigned chapter.

- 05% Outreach
- 10% Quizzes
- 25% Homeworks & Robot Demos
- 20% Exam 1
- 20% Exam 2
- 20% Final Project
- You are allowed to discuss the homework problems and projects with your classmate but you cannot copy your classmate's homework and project.
- Suspected cases of dishonesty will be promptly submitted to department's hearing officer, as per the University of Houston's Academic Honesty policy.

In addition, graduate students will be expected to complete an additional research-related project. This project will be worth 10% of the final grade. Overall scores for graduate students will be divided by 1.1 to scale the maximum possible score of 110% down to 100%.

Outreach: The instructors strongly believe the best way to learn a subject is to teach it. For this reason, students are required to complete a robotics outreach with local K-12 students.

Academic Honesty Policy: Students in this course are expected to follow the *Academic Honesty Policy* of the University of Houston. It is your responsibility to know and follow this policy. You must sign and submit the Academic Honesty Statement on the course blackboard site. If you fail to do this, you may be dropped from the course. For more information, see the *Academic Honesty* in the *Undergraduate Catalog* which is available on-line at http://catalog.uh.edu/content.php?catoid=8&navoid=1352

Religious Holy Days: Students whose religious beliefs prohibit class attendance on designated dates or attendance at scheduled exams may request an excused absence. To do this, you are **strongly encouraged** to request the excused absence, in writing, by Wednesday, February 4, 2017. Please submit this written request to your instructor to allow the instructor to make appropriate arrangements.
More information can be found at
http://www.uh.edu/dos/studenthandbook/academicpolicy/a_holydays.html

Students with Disabilities: Students with recognized disabilities will be provided reasonable accommodations, appropriate to the course, upon documentation of the disability with a *Student Accommodation Form* from the *Center for Students with Disabilities*. To receive these accommodations, you must request the specific accommodations, by submitting them to the instructor in writing, by Wednesday, February 4, 2017. Students who fail to submit a written request will not be considered for accommodations. More information, can be found at
http://www.uh.edu/dos/studenthandbook/academicpolicy/a_disability.html

Attendance: Attendance at all classes is expected and required. The instructor may, if he chooses, take attendance in any class, at any time during the class. The instructor may do this as many times per class period as he chooses, without warning. The attendance grade can be included in the grade for the course. Attendance at every class is expected. Roll will be occasionally taken and an in-class exam may be given during any class period. There will be no make-up of missed in-class exams.

Grade Posting: You may find out your grade in the course online using PeopleSoft. Normally, the grades are available about one week after the final exam. The instructor is not allowed to give out grades over the phone or by email. During the semester, grades will be posted on Blackboard in a secure manner, i.e., so that only you will have access to your grades. Final grades will also be posted on Blackboard at the end of the semester; however, the official grade reporting is done on PeopleSoft, not on the Blackboard.

Counseling and Psychological Services (CAPS) can help students who are having difficulties managing stress, adjusting to co llege, or feeling sad and hopeless. You can reach CAPS (http://www.uh.edu/caps/) by calling 713-743-5454
during and after business hours for routine appointments or if you or someone you know is in crisis.
Also, there is no appointment necessary for the "Let's Talk" program, which is a drop-in consultation service at convenient locations and hours around campus. http://www.uh.edu/caps/outreach/lets_talk.html

Grade Point Rule: The following **approximate** grade point scale will be used in determining your grade. This scale may be modified somewhat, but is included here so that you will have a general idea of how well you are doing in the course. The final grade scale will be determined at the end of the semester.

90–100: A's 80–89.9: B's 70–79.9: C's 60–69.9: D's <60: F

Extra Credit:
Mathematica Demonstrations are important to the instructor. A *published* (before the end of the semester), intro-to-robotics-related Mathematica demonstration (with Dr. Becker as a coauthor), will add 2.5 to 7.5% to your final grade. Some topics include • demonstration on inverse velocity kinematics as robot traces out a square and circle, • motion planning in a grid world for 2-link robot (BFS)• visualization of robot workspace • configuration vs. workspace of an RR robot • configuration vs. workspace of polygonal robot • visualization of workspace singularities • update of demonstrations.wolfram.com/PathsInsideAPolygon/ to show configuration space planning of polygonal robot.
Links to previous demonstrations (many of these students were hired as summer REUs/PhD students because of their work)

- demonstrations.wolfram.com/ForwardAndInverseKinematicsForTwoLinkArm/

- demonstrations.wolfram.com/RobotMotionWithObstacles/
- demonstrations.wolfram.com/ChartForATorus/
- demonstrations.wolfram.com/MeasuringDistanceAndOrientationUsingCameraAndLasers/
- demonstrations.wolfram.com/ManipulabilityEllipsoidOfARobotArm/
- demonstrations.wolfram.com/DenavitHartenbergParametersForAThreeLinkRobot/

Withdrawal Policy: The withdrawal dates listed in the Academic Calendar section of the *Class Schedule* will be followed strictly. You may drop the course without receiving a grade until Wednesday, February 4, 2015 which is the University's last day to drop without receiving a grade. After this date and until Monday April 6, which is the University's last day to drop, you may drop with a W if you have not exceeded your total W limit (the limit applies to undergraduate students only). Grades of Incomplete (I) will be given only when a small portion of the course has not been completed for a good reason. If the material has been completed, an "I" grade cannot be given. Detailed information about these issues is available in the University of Houston Undergraduate Catalog.

Blackboard: We will be using the Blackboard Learn web site (http://www.uh.edu/blackboard) for posting of grades and email. We will assume that your UH email alias (joejones@uh.edu) is pointed to a working email server, and that you are available at that address.

Related Robotics Courses:
Consider taking MECE 3400 "Introduction to Mechanics" , COMP 550 001 at Rice « Algorithmic Robotics »
COSC 4332 or 6332 - Medical Robots & Interventions, INDE 7361 - Industrial Robotics
ECE 6325 - State-Space Control Systems, ECE 6335 - Digital Control Systems, ECE 6390 - Linear Multivariable Control Systems, ECE 7333 - Optimal Control Systems, ECE 7334 - Advanced Digital Control Systems

Exam Schedule: The FINAL EXAM will be given on Thurs., May 4 from 11:00 am-2:00 pm, www.uh.edu/academics/courses-enrollment/final-exam-schedules/

Late Policy: worksheets and homework are due on blackboard 10 minutes before class begins. At the TA discretion, late homeworks *might* be graded with at least a 10% penalty per day late.

Goals: By the course end, you will be able to implement and use:
Coordinate transforms, rotation matrices, Denavit-Hartenberg convention, Robotics kinematics and inverse kinematics, velocity kinematics and inverse velocity kinematics, basic computer vision, path planning artificial potential fields, sampling-based methods. By building your own robot arm, you will integrate these topics with robotic hardware.

Note: Reading assignments should be completed *before* the lecture for which they are assigned.

#:Date	Topic	Assignments
1:Jan 16	General introduction and overview of the course	Read Chap. 1, AGITR
2:Jan 18	Getting started with ROS	Read Chap. 2, AGITR
3:Jan 23	Writing ROS programs	Read Chap. 3, AGITR, HW1 due
4:Jan 25	Log messages	Read Chap. 4, AGITR
5:Jan 30	Graph resource names	Read Chap. 5, AGITR, HW2 due
6:Feb 2	Launch Files	Read Chap. 6, AGITR
7:Feb 6	Parameters	Read Chap. 7, AGITR, HW3 due
8:Feb 8	Services	Read Chap. 8, AGITR
9:Feb 13	Recording and replaying messages	Read Chap. 9, AGITR
10: Feb 15	Review of AGITR	Read Chap. 10, AGITR, Chap 1 PRwR
11: Feb 20	ROS Fundamentals	Skim Chap 2-6 PRwR , HW4 due
12: Feb 22	Wanderbot	Read Chap 7 PRwR
13: Feb 27	Teleop-bot	Read Chap 8 PRwR
14: Mar 1	Building maps of world	Read Chap 9 PRwR
15: Mar 6	Navigating about world	Read Chap 10 PRwR , HW5 due
16: Mar 8	Chess-bot	Read Chap 11 PRwR

Mar 13	SPRING BREAK	
Mar 15	SPRING BREAK	teach someone about robotics!
17: Mar 20	Follow-bot	Read Chap 12 PRwR, HW6 due
18: Mar 22	On Patrol	Read Chap 13 PRwR
19: Mar 27	Stockroom-bot	Read Chap 14 PRwR
Mar 29	**Exam 1**	
20: Apr 3	Your own Sensors and Actuators	Read Chap 15 PRwR , HW7 due
21: Apr 5	Your own Mobile Robot: I	Read Chap 16 PRwR
22: Apr 10	Your own Mobile Robot: II	Read Chap 17 PRwR
23: Apr 12	Your own robot arm	Read Chap 18 PRwR, HW8 due
Apr 18-22	*Swarmathon* at NASA Kennedy Space Center	
24: Apr 17	Adding a software library	Read Chap 19 PRwR
25: Apr 19	Tools	Read Chap 20 PRwR, Final project report due
26: Apr 24	Final Project Presentations	
27: Apr 26	Final Project Presentations	
May ??	Final Exam ?? from ??	

Blackboard Login Information

Please note: **Not all instructors choose to use the Blackboard course management system.**

Blackboard:

Bb Login: accessUH.uh.edu or elearning.uh.edu or uh.edu/blackboard

Username: same as your **CougarNet UserID***

Password: same as your **CougarNet Password****

***Reset* CougarNet Password:** *(3 options)*

- go to **https://accessUH.uh.edu** > **Change CougarNet Password** > select *"I forgot my CougarNet password or need it reset."* > follow prompts.
- go to **http://uh.edu/password** > select *"I forgot my CougarNet password or need it reset."* > follow prompts.
- go to **www.uh.edu/infotech** > Password Reset > select *"I forgot my CougarNet password or need it reset."* > follow prompts.

***Change* CougarNet Password:** *(3 options)*

- go to **https://accessUH.uh.edu** > **Change CougarNet Password** > select *"I need to change my CougarNet password."* > follow prompts.
- go to **http://uh.edu/password** > *"I need to change my CougarNet password."* > follow prompts.
- login to **CougarNet** > **Control+Alt+Delete** > click **Change Password** in dialog box > enter **Old Password** > enter **New Password** > **Confirm**.

Need Help?

Contact the UIT Support Center

- ***by phone***: 713-743-1411
- ***online***: **support@uh.edu**
- ***live chat***: **www.uh.edu/infortech/livechat**
- ***in person***: Room 58 (basement) or 1st floor of MD Anderson Library
- ***UH Help*** tab in Blackboard

If you do not know your **CougarNet UserID, you may request it at **https://accessuh.uh.edu**, contact UIT Support Center at 713-743-1411, or go to the Engineering Computing Center (ECC) front desk (W-129, Engineering Bldg. 2) with your Cougar Card - ECC staff can help you.*

***If you do not know your **CougarNet password**, see options under "Reset CougarNet Password" above.*