CS480 / 680 Robotics & 3D Printing - Fall 2018

Credits 3

Prerequisites CS 311 or equivalent experience programming complex applications in a modern language like C++ or Python, and Math 252 (Calculus III).

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Office Hours MTWRF 3:30pm - 5pm

Meeting Time TR 11:30am - 1pm

Course Room Duckering 342

Course Website https://www.cs.uaf.edu/2018/fall/cs480

Required Text

Title: Probabilistic Robotics
Authors: Sebastian Thrun, Wolfram Burgard, Dieter Fox
Publisher: The MIT Press
Year: 2005
ISBN-10: 0262201623
https://www.amazon.com/Probabilistic-Robotics-Intelligent-Autonomous-Agents/dp/0262201623/

Course Description

Self-driving cars, 3D printers, and computer-controlled machine tools are modern applications of a common software core of path planning and motion control. This course will cover the mathematical background in 3D computational geometry, hands-on applications such as designing and printing high strength robot parts, and online algorithms for driving robots. Specific topics will be adapted according to student interest, but will include parametric 3D part design in the OpenSCAD constructive solid geometry programming language, computational geometry such as 3D printer slicing algorithms, creating and optimizing offline motion plans such as gcode, robot control system design and construction with Arduino microcontrollers and off-the-shelf motor controllers,

network-centric robotics using the UAF-developed SuperStar web infrastructure, robot online motion control algorithms, computer vision techniques such as color matching and machine-readable markers, and algorithms for mobile robot localization and navigation in structured and unstructured environments. Hands-on experiments and tools will be available, including several 3D printers, CNC hardware, and a variety of mobile robots including Roombas and LAYLA telepresence hardware. Prerequisites: CS 311 or equivalent experience programming complex applications in a modern language like C++ or Python, and Math 252 (Calculus III).

Student Learning Outcomes

After taking this course, students will be able to:

- write OpenSCAD code to create a 3D-printer friendly robot part.
- explain how to use path planning to slice a 3D printed model.
- explain how to use path planning to drive a robot's joints.

Course Schedule (Tentative)

For the week starting:

1. Aug 28: Field overview and survey of sensors
2. Sep 04: OpenSCAD for parametric 3D part design
3. Sep 11: 3D printing: slicing and support material
4. Sep 18: Arduino and stepper interfacing
5. Sep 25: DC motor servos: position feedback and control
6. Oct 02: Proportional, Integral, Derivative (PID) control and aero-beam
7. Oct 09: High dimensional path planning: configuration space
8. Oct 16: Computer vision and color matching with OpenCV
9. Oct 18: Midterm exam in class
10. Oct 23: Project 1 presentations
11. Oct 30: Optical flow and feature points in OpenCV
12. Nov 07: Computer vision marker design and accuracy
13. Nov 13: Kinect depth camera object recognition
14. Nov 20: Iterative Closest Point and pose estimation
    - Nov 22 Thursday: no class due to Thanksgiving
15. Nov 26: Simultaneous Localization and Mapping (SLAM)
16. Dec 3: Project 2 presentations
17. 10:15 a.m.-12:15 p.m., Thursday, December 13: Final Exam

Grading Policies

Weight	Description
5%	Attendance and class participation, graded at random intervals throughout the semester
15%	Homework problems, to be assigned through the semester
25%	Project 1, an independent project in robotics and/or 3D printing, typically due near the time of the midterm exam
25%	Project 2, a second independent project in robotics and/or 3D printing, possibly an extension of Project 1, typically due near finals week.
15%	Midterm exam, held in class in mid-October
15%	Final exam, held on finals week in December

Grades will be assigned based on the following percentage intervals:

A+	*	**A**	[93%, 100%)	**A-**	[90%, 93%)
B+	[87%, 90%)	**B**	[83%, 87%)	**B-**	[80%, 83%)
C+	[77%, 80%)	**C**	[73%, 77%)	**C-**	[70%, 73%)
D+	[67%, 70%)	**D**	[63%, 67%)	**D-**	[60%, 63%)
F	[0%, 60%)				

* A+ indicates truly exceptional work, above and beyond the course requirements.

Differences between the graduate section (680) and undergraduate section (480):

- 680 students will format their project 2 report like a scientific paper, with an abstract, prior work, figures, and references. 480 students will format their project reports like a blog post.
- 680 students will be assigned papers as readings from the technical literature, which will appear on the 680 exams.

Late Work Policy

Late work will not be graded, unless it is due to circumstances beyond your control, or if you turn it in before I begin grading. I may begin grading at any time after the due date, even 12:01am the next day (grading is an effective treatment for insomnia!). You are encouraged to inquire if I have begun grading yet, since this acts as a reminder for me to do so.

Policies

Students are expected to be at every class meeting on time, and are responsible for all class content, whether present or not. If absence from class is necessary, in-class work (other than quizzes) and homework may be made up only if the instructor is notified as soon as possible; in particular, absences due to scheduled events must be arranged ahead of time. Academic dishonesty will not be tolerated, and will be dealt with according to UAF procedures. Students in this class must pay the CS lab fee. Payment allows access to the Duckering 536 lab.
UAF academic policies http://catalog.uaf.edu/academics-regulations/
CS Department policies http://www.cs.uaf.edu/departmental-policies/

Inclusion Statement

UA is an AA/EO employer and educational institution and prohibits illegal discrimination against any individual: www.alaska.edu/nondiscrimination

The University of Alaska Board of Regents have clearly stated in BOR policy that discrimination, harassment and violence will not be tolerated on any campus of the University of Alaska. If you believe you are experiencing discrimination or any form of harassment, including sexual harassment/misconduct/assault, you are encouraged to report that behavior. If you disclose sexual harassment or sexual violence to faculty members or university employees, they must notify the UAF Title IX coordinator about the basic facts of the incident. Your choices for disclosure include:

1. You may confidentially disclose and access confidential counseling by contacting the UAF Health and Counseling Center at 474-7043.
2. You can get support and file a Title IX report by contacting the UAF Title IX coordinator at 474-7599.
3. You may file a criminal complaint by contacting the UAF Police Department at 474-7721.

From Disability Services: UAF is obligated to provide accommodation only to the known limitations of an otherwise qualified student who has a disability. Please identify yourself to UAF Disability Services by applying for accommodations. To be considered for UAF Disability Services accommodations, individuals must be enrolled for at least one credit as a UAF student. For more information contact Disability Services at uaf-disabilityservices@alaska.edu, 474-5655 or by TTY at 474-1827.