Syllabus

Course Title: CSCE 574 Robotics

Instructor: Ioannis Rekleitis,
Storey Innovation Center
Computer Science and Engineering
Room 2235
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Class meeting:

Sweringen 2A18 M/W 14:20 – 15:35

Final Exam standard time.

Course Description: From the surface of Mars and the far reaches of our Solar System to the bottom of the ocean, robots are helping us expand our scientific understanding of the universe. In our everyday life, devices that gather information and interact with the environment are ever-present, taking over many of the undesirable or dangerous tasks that humans had to perform previously. Fundamental to all these robotic devises is their ability to sense the environment, reason about it, and then plan and safely execute the best action. This course is designed as an advance graduate course with a focus on design and operation of robot systems; dynamics, control, and motion trajectories of mobile robots; vision, LIDAR, SONAR and tactile sensing systems; state estimation; planning and learning.

At the beginning we will discuss how robots move and interact with their environment. Among other topics we will examine the underlying hardware enabling mobility, kinematics and inverse kinematics, and also the differences between manipulators and mobile robotic systems. Perception of the environment is another fundamental skill for intelligent systems. Sensors, sensor data interpretation, and sensor fusion would be presented next, including recent advances in the field of sensor networks. Reasoning about the environment and the actions a robot takes is the third area we would cover in this course. This would include path planning for mobile robots and configuration spaces for manipulators. The task of mapping, with the underpinning concepts of position estimation and localization, will be explored. We will go over the notion of multi-agent systems, and finally look at applications of robotics in the real world.

The course material would cover the fundamentals of intelligent robotic systems with special focus on the computational aspects. The students would also have the chance to apply some of the theoretical concepts seen in class on a mobile robot (TurtleBots, Tello UAV). The instructor would draw from his experiences in robotic research to enrich the material with aspects of active research problems, such as: multi-robot coverage for humanitarian demining; environmental coral reef monitoring using an underwater robot; robotic planetary exploration; etc. Even though the focus of this course is on mobile robotics, the methodologies discussed can be applied to a variety of computer systems equipped with sensors and actuators.

Course learning outcomes:

- Develop the ability to work with different robot platforms
- Develop the ability to understand basic robotic algorithms: Planning, Sensing, Acting

Prerequisites:

CSCE 211, 212, 240.

Required text(s):

The required textbook: is:

- **Computational Principles of Mobile Robotics**, Gregory Dudek and Michael Jenkin, 2rd Edition, Cambridge University Press

Other texts include:

- A Gentle Introduction to ROS, Jason M. O'Kane, Independently published, 2013

Schedule, deliverables, and evaluation:

Component	**Undergraduate**	**Graduate**
Assignments (5)	10%	10%
• First two individual • Last three 50% team, 50% individual		
Graduate/Extra Credit Bibliography search assignment		10%
Homeworks (5)	10%	10%
Midterm Exam	15%	15%
Final Exam (standard time)	25%	25%
Total	**100%**	**100%**

Schedule:

Week 01: Syllabus presentation, Round Table, Introduction, History of Robotics. ROS
Week 02: Actuators. Locomotion. Sensor (Tactile, Range Finders, GPS, IMU, Position Encoders).
Week 03: Reactive Path Planning. Potential Fields. State Estimation,
Week 04: Bayesian Filtering Particle Filters
Week 05: Kalman Filters
Week 06: Exploration, HRI
Week 07: Mapping: Metric Maps, Topological Maps, hybrid.
Week 08: Visibility Graphs, Bug Algorithm, Generalized Voronoi Graphs, Atlas.
Week 09: Coordinate Systems, Control
Week 10: Semantic hierarchy of spatial representations. Configuration Space, PRMs
Week 11: Architectures.
Week 12: Coverage, Multi-Robot Coverage
Week 13: Learning in Robotics
Week 14: Sensors (Vision).
Week 15: Review of Material

Teaching style
The class will be meeting in person Mon/Wed. It will be very important for you to follow each lecture in a timely manner. There will be a hardware component, a robot kit, which will be distributed in class. If you are not present, it is your responsibility to arrange for pickup. Assignments and exams will be returned within one week. If there are any delays, there will be an announcement. The instructor will try to answer emails in 24h, or by sending a message to everyone through the dropbox.cse.sc.edu system, or in class.

- Student-to-Instructor (S2I) Interaction: Students will attend/listen/view lectures in person and interact with the professor in class through email. The professor will post regular announcements, provide individual feedback to students, and hold office hours at the lab. In addition the instructor will send messages through the CSE Moodle server (https://dropbox.cse.sc.edu).
- Students-to-Student (S2S) Interaction: Students will engage in discussions through email, in person, and in the lab.
- Student-to-Content (S2C) Interaction: Students will engage with course content by completing assignments and participating in lab sessions, and face to face lectures.

Grading Scheme:

>90% : A
>87% : B+

>80% : B

>77% : C+

>70% : C

>60% : D

<60% : F

How to do poorly

Here are some habits that have correlated with poor performance in this course in the past:

- **Not starting/making progress on the programming assignments until the last minute**
- Skipping class
- Ignoring the communications from the instructor
- Not properly reading the instructions
- Ignoring the homework
- Not asking questions and interacting with the instructor

Course Policies:

- Late assignments: Unless the course schedule prevents it, programming assignments will be accepted up to three days late, subject to a 10% penalty for each day or fraction of a day.
- Computing platform: You will be expected to write software to control real robots. These tasks are most straightforward in the Python language or C++. You are also welcome to identify and use other appropriate languages if you prefer, provided that using such a language does not trivialize the assignment. However, we will not provide assistance with this.
- The hardware used this year will require the use of a Linux based computer.
- Policy changes: Changes to the syllabus at the instructor's reasonable discretion, including changes to the evaluation and grading mechanisms, are possible but unlikely.

Graduate/Honor Grading Policy:

Graduate and Honors student we will have an additional part on each assignment, which will count for ten percent of the marks. Failure to complete these parts will cost one letter grade.

Academic Integrity:

You are expected to practice the highest possible standards of academic integrity. Any deviation from this expectation will result in a minimum academic penalty of

your failing the assignment, and will result in additional disciplinary measures. This includes improper citation of sources, using another student's work, and any other form of academic misrepresentation.

University policies and procedures regarding academic integrity are defined in policy STAF 6.25, Academic Responsibility - The Honor Code (see http://www.sc.edu/policies/ppm/staf625.pdf). Prohibited behaviors include plagiarism, cheating, falsification, and complicity. All potential Honor Code violations will be reported to the Office of Student Conduct and Academic Integrity, which has the authority to implement non-academic penalties as described in STAF 6.25. Academic penalties for Honor Code violations in this course range from a zero on the assignment to failure of the course.

Use of online resources that contain the solution to a homework/assignment/exam is strictly prohibited and will result to failure of the course.

Attendance Policy:

When you miss class, you miss important information. In these days of COVID 19, that means either physical or virtual. If you are absent, you are responsible for learning material covered in class. If you are absent when an assignment is due, you must have submitted the assignment prior to the due date to receive credit. It is your responsibility to follow along.

Accommodating Disability:

Reasonable accommodations are available for students with a documented disability. If you have a disability and may need accommodations to fully participate in this class, contact the Office of Student Disability Services: 777-6142, TDD 777-6744, email sasds@mailbox.sc.edu, or stop by LeConte College Room 112A. All accommodations must be approved through the Office of Student Disability Services.

Diversity:

In order to learn, we must be open to the views of people different that ourselves. In this time we share together over the semester, please honor the uniqueness of your fellow classmates and appreciate the opportunity we have to learn from one another. Please respect each others' opinions and refrain from personal attacks or demeaning comments of any kind. Finally, remember to keep confidential all issues of a personal or professional nature that are discussed in class.