FLORIDA ATLANTIC UNIVERSITY

COT 6930-001 13501

Intro Intelligent Auton Robots

Date: Tuesday, Thursday 9:30 AM - 10:50 AM

Building: General Classroom South Boca **Room:** 116

3 Credit(s)

Fall 2024 - 1 Full Term

Instructor Information

Minghan Wei
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Office: EE-513
Office Hours: Wednesday 1 p.m. - 3 p.m.
Phone: 561-297-0432

Course Description

Topics in Computer Science
PREREQUISITES: Permission of instructor
Variable title

In this course we will introduce the fundamental knowledge in robotic perception, planning, and control. Topics include spatial representations and transformations among robot components, kinematics/inverse kinematics, robot perception (computer vision), basic mapping and path planning algorithms. Students will get hands-on experiences with robotic systems via real robots or simulations using ROS2.

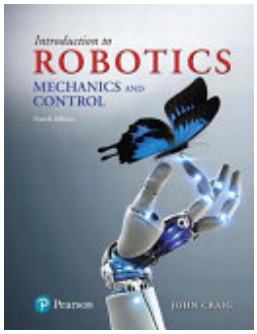
- Experiences in a programing language with courses COP 2220 / COP 3035.

- Some familiarity with the matrices (multiplication, inverse, eigenvalues, eigenvectors). MAS 2103 Matrix Theory is preferred but not required.
- Calculus (basic knowledge about derivatives/gradients)

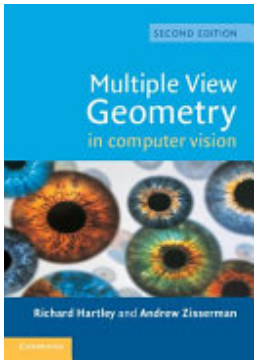
Required Texts/Materials

No textbooks are required. The following textbooks can be used for reference.

Recommended Readings and Materials



Introduction to Robotics
ISBN: 9780133489798
Authors: John J. Craig
Publication Date: 2018-01-01
3rd edition is freely available online at link.



Multiple View Geometry in Computer Vision
ISBN: 9780521540513
Authors: Richard Hartley, Andrew Zisserman
Publisher: Cambridge University Press
Publication Date: 2003-01-01

Course Objectives/Student Learning Outcomes

Course objectives:

- Students will be able to represent the rigid body pose in 3D world and describe the relative pose of one object with another.
- Calculate pixel locations in an image of 3D points to demonstrate comprehension of the camera project model.
- Students will be able to draw the general pipeline of SLAM (simultaneous of localization and mapping)

- Students will be able to identify the classical robotic path planning problems, and algorithms, compare their advantages and disadvantages.
- Students will be able to complete programming using ROS2 to move robots either in simulators or practical application settings.

ABET Student Outcomes relevant to this course:

- Student Outcome 1 (SO1): An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (Problem Solving).
- Student Outcome 2 (SO2): An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. (Design).
- Student Outcome 6 (SO6): An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgement to draw conclusions. (Experimentation and/or simulation)

Faculty Rights and Responsibilities

Florida Atlantic University respects the rights of instructors to teach and students to learn. Maintenance of these rights requires classroom conditions that do not impede their exercise. To ensure these rights, faculty members have the prerogative to:

• Establish and implement academic standards.

• Establish and enforce reasonable behavior standards in each class.

• Recommend disciplinary action for students whose behavior may be judged as disruptive under the Student Code of Conduct University Regulation 4.007.

Disability Policy

In compliance with the Americans with Disabilities Act Amendments Act (ADAAA), students who require reasonable accommodations due to a disability to properly execute coursework must register with Student Accessibility Services (SAS) and follow all SAS procedures. SAS has offices across three of FAU's campuses – Boca Raton, Davie and Jupiter – however disability services are available for students on all campuses. For more information, please visit the SAS website at www.fau.edu/sas/.

Course Evaluation Method

- Assignments: 40%

    - Spatial representation and coordinate transformation (10%)
    - Camera calibration (10%), feature extraction and matching (10%)
    - Camera localization (10%)
- Mid-term exam: 20%
- Course project (in groups. Ground size depends on the number of enrollments): 40%
    - Project proposal: 5%
        - Project report: 10%
        - Project final presentation: 25%
- Bonus points
    - Organizing the project report in the format of academic (IEEE) conference papers (5%)
    - Work on an actual robot for the course project (5%-10%).

Code of Academic Integrity

Students at Florida Atlantic University are expected to maintain the highest ethical standards. Academic dishonesty is considered a serious breach of these ethical standards, because it interferes with the university mission to provide a high quality education in which no student enjoys an unfair advantage over any other. Academic dishonesty is also destructive of the university community, which is grounded in a system of mutual trust and places high value on personal integrity and individual responsibility. Harsh penalties are associated with academic dishonesty. For more information, see University Regulation 4.001.

Attendance Policy Statement

Students are expected to attend all their scheduled University classes and to satisfy all academic objectives as outlined by the instructor. The effect of absences upon grades is determined by the instructor, and the University reserves the right to deal at any time with individual cases of non-attendance. Students are responsible for arranging to make up work missed because of legitimate class absence, such as illness, family emergencies, military obligation, court-imposed legal obligations, or participation in University-approved activities. Examples of University-approved reasons for absences include participating on an athletic or scholastic team, musical and theatrical performances, and debate activities. It is the student's responsibility to give the instructor notice prior to any anticipated absences and within a reasonable amount of time after an unanticipated absence, ordinarily by the next scheduled class meeting. Instructors must allow each student who is absent for a University-approved reason the opportunity to make up work missed without any reduction in the student's final course grade as a direct result of such absence.

Religious Accommodation Policy Statement

In accordance with the rules of the Florida Board of Education and Florida law, students have the right to reasonable accommodations from the University in order to observe religious practices and beliefs regarding admissions, registration, class attendance, and the scheduling of examinations and work assignments. University Regulation 2.007, Religious Observances, sets forth this policy for FAU and may be accessed on the FAU website at www.fau.edu/regulations.

Any student who feels aggrieved regarding religious accommodations may present a grievance to the executive director of The Office of Civil Rights and Title IX. Any such grievances will follow Florida Atlantic University's established grievance procedure regarding alleged discrimination.

Time Commitment Per Credit Hour

For traditionally delivered courses, not less than one (1) hour of classroom or direct faculty instruction each week for fifteen (15) weeks per Fall or Spring semester, and a minimum of two (2) hours of out-of-class student work for each credit hour. Equivalent time and effort are required for Summer Semesters, which usually have a shortened timeframe. Fully Online courses, hybrid, shortened, intensive format courses, and other non-traditional modes of delivery will demonstrate equivalent time and effort.

Course Grading Scale

Letter Grade	Letter Grade
A	94 - 100%
A-	90 - 93%
B+	87 - 89%
B	83 - 86%
B-	80 - 82%
C+	77 - 79%
C	73 - 76%
C-	70 - 72%
D+	67 - 69%
D	63 - 66%
D-	60 - 62%
F	Below 60

Grade Appeal Process

You may request a review of the final course grade when you believe that one of the following conditions apply:

• There was a computational or recording error in the grading.

• The grading process used non-academic criteria.

• There was a gross violation of the instructor's own grading system.

University Regulation 4.002 of the University Regulations contains information on the grade appeals process

Policy on Make-up Tests, Late work, and Incompletes

Late Assignments: All assignments are due at 11:59 pm on the due date. Late assignments will lose 10% of the total points for each day they are late and they will not be accepted after 3 days. However, appropriate accommodations will be made for students having a valid medical excuse.

Make-up policy for tests: Makeup tests are given only if there is solid evidence of a medical or otherwise serious emergency that prevented the student from participating in the exam. Unless there exists evidence of a medical or emergency situation, incomplete grades will not be given.

Incomplete grade policy: Incomplete grades are against the policy of the department. Unless there is solid evidence of a medical or otherwise serious emergency situation and the student is currently passing the class, incomplete grades will not be given.

Policy on the Recording of Lectures

Students enrolled in this course may record video or audio of class lectures for their own personal educational use. A class lecture is defined as a formal or methodical oral presentation as part of a university course intended to present information or teach students about a particular subject. Recording class activities other than class lectures, including but not limited to student presentations (whether individually or as part of a group), class discussion (except when incidental to and incorporated within a class lecture), labs, clinical presentations such as patient history, academic exercises involving student participation, test or examination administrations, field trips, and private conversations between students in the class or between a student and the lecturer, is prohibited. Recordings may not be used as a substitute for class participation or class attendance and may not be published or shared without the written consent of the faculty member. Failure to adhere to these requirements may constitute a violation of the University's Student Code of Conduct and/or the Code of Academic Integrity.

Artificial Intelligence Preamble

FAU recognizes the value of generative AI in facilitating learning. However, output generated by artificial intelligence (AI), such as written words, computations, code, artwork, images, music, etc., for example, is drawn from previously published materials and is not your own original work.

FAU students are not permitted to use AI for any course work unless explicitly allowed to do so by the instructor of the class for a specific assignment. **[Policy 12.16 Artificial Intelligence]**

Class policies related to AI use are decided by the individual faculty. Some faculty may permit the use of AI in some assignments but not others, and some faculty may prohibit the use of AI in their course entirely. In the case that an instructor permits the use of AI for some assignments, the assignment instructions will indicate when and how the use of AI is permitted in that specific assignment. It is the student's responsibility to comply with the instructor's expectations for each assignment in each course. When AI is authorized, the student is also responsible and accountable for the content of the work. AI may generate inaccurate, false, or exaggerated information. Users should approach any generated content with skepticism and review any information generated by AI before using generated content as-is.

If you are unclear about whether or not the use of AI is permitted, ask your instructor before starting the assignment.

Failure to comply with the requirements related to the use of AI may constitute a violation of the **Florida Atlantic Code of Academic Integrity, Regulation 4.001.**

Proper Citation: If the use of AI is permitted for a specific assignment, then use of the AI tool must be properly documented and cited. For more information on how to properly cite the use of AI tools, visit **https://fau.edu/ai/citation**

AI Language Specific To This Course

Using AI tools to help with learning is allowed. But directly copying and pasting results from them for homework questions is strictly prohibited and will be regarded as a violation of academic integrity.

Counseling and Psychological Services (CAPS) Center

Life as a university student can be challenging physically, mentally and emotionally. Students who find stress negatively affecting their ability to achieve academic or personal goals may wish to consider utilizing FAU's Counseling and Psychological Services (CAPS) Center. CAPS provides FAU students a range of services – individual counseling, support meetings, and psychiatric services, to name a few – offered to help improve and maintain emotional well-being. For more information, go to http://www.fau.edu/counseling/

Student Support Services and Online Resources

- Center for Learning and Student Success (CLASS)
- Counseling and Psychological Services (CAPS)
- FAU Libraries
- Math Learning Center
- Office of Information Technology Helpdesk
- Center for Global Engagement
- Office of Undergraduate Research and Inquiry (OURI)
- Science Learning Center
- Speaking Center
- Student Accessibility Services
- Student Athlete Success Center (SASC)
- Testing and Certification
- Test Preparation
- University Academic Advising Services
- University Center for Excellence in Writing (UCEW)
- Writing Across the Curriculum (WAC)

Course Topical Outline

- Overview of robotic applications
- Introduction to ROS2
- Spatial descriptions and transformations
- Kinematics of manipulators and mobile robots
- Robot perception
- Camera models: intrinsic and extrinsic parameters
- Image feature extraction and matching
- Epipolar Geometry and camera pose estimation
- Localization using P3P, PnP
- Structure-from-motion pipeline
- Path planning algorithms for mobile robots