EEL 3664 INTRODUCTION TO AUTONOMOUS SYSTEMS
Florida International University
Department of Electrical and Computer Engineering
Fall Semester, 2022 (ABET Updated)

Classroom	:	EC2420
Class Time	:	Monday and Wednesday 9:30 AM - 10:45 AM
Faculty	:	Dr. Ou Bai
Office Hours	:	Either scheduled appointment or after class. Please send an email to obai@fiu.edu to make an appointment. Please include your name, preferred time (give three if possible), how long needed, what to discuss, and other necessary information.
Office	:	10555 W. Flagler Street, Room 3954
Phone	:	(305) 348-3704
Email	:	obai@fiu.edu
Prerequisite	:	C/C++ and/or Java Experience is required e.g., EEL 2880 Applied Software Techniques in Engineering
Textbook	:	Siegwart, Nourbaksh and Scaramuzza, Introduction to Autonomous Mobile Robots, 2nd Edition. MIT Press, 2011. ISBN: 9780262015356 Nikolaus Correll, Introduction to Autonomous Robots, Magellan Scientic. ISBN-13: 978-0692700877. Free Online version can be obtained: https://open.umn.edu/opentextbooks/textbooks/introduction-to-autonomous-robots Jitendra R. Raol, Mobile Intelligent Autonomous Systems. CRC Press. ISBN:9781439863015 (Reference Only)
Course Materials	:	This course will use a mobile robot simulator CoppeliaSim for two projects. A free Education (Edu) version can be downloaded from https://www.coppeliarobotics.com/downloads.

Catalog Description
This course provides a comprehensive introduction to the components of autonomous systems and exposes the students to the concept of autonomous systems from the perspective of autonomous mobile robotic. (3 credits)

Course Objectives
The objective of this course is to introduce the students to the concept of autonomous systems. Autonomous systems are capable of perceiving, reason about, and act autonomously in a variety of situations and environments. The topics in the course will expose the students to the fundamental building blocks of autonomous systems, ranging from hardware, software, system integration, low-level system control to high-level intelligent control. Throughout the

course, the students will have the opportunity to apply the concepts learned in class to build and program an autonomous mobile robotic system.

Prerequisite

- C/C++ and/or Java, e.g., EEL 2880 Applied Software Techniques in Engineering

Textbook

- Siegwart, Nourbaksh and Scaramuzza, Introduction to Autonomous Mobile Robots, 2nd Edition. MIT Press, 2011. ISBN: 9780262015356
- Nikolaus Correll, Introduction to Autonomous Robots, Magellan Scientic. ISBN-13: 978-0692700877.

Course Materials

- This course will use a mobile robot simulator coppeliaSim for two projects. A free Education (EDU) version can be downloaded from https://www.coppeliarobotics.com/downloads.

Topics Covered

- Autonomous system fundamentals
- C/C++ programming
- Sensors and actuators
- Vision and Feature Extraction
- Embedded systems and control for robotic
- Localization
- Introduction to navigation, planning, and decision making

Relationship of course to ABET objectives

☒ 1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

☒ 2. 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.

☐ 3. an ability to communicate effectively with a range of audiences.

☐ 4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.

☒ 5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.

☒ 6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

☒ 7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Grading Scheme

Homework/Problem Sets	**20%**
Projects and Reports	**40%**
Two Pop-Up Quiz (Not Scheduled)	**10%**
Two Scheduled Quiz/Exam (15% each)	**30%**
Total	**100%**

Team-based Project Group

Each project team will have four students. Students in the team will contribute to the project evenly. The course instructor will exam the students' project contribution in the project report.

Grading Scale

A	100-95	**B+**	86-90	**C+**	75-80	**D**	60-70	**F**	0-60
A-	90-95	**B**	83-86	**C**	70-75				
		B-	80-83						

Tentative Exam Dates

- The 8th week
- The 14th Week

University's Code of Academic Integrity

Florida International University is a community dedicated to generating and imparting knowledge through excellent teaching and research, the rigorous and respectful exchange of ideas, and community service. All students should respect the right of others to have an equitable opportunity to learn and honestly to demonstrate the quality of their learning. Therefore, all students are expected to adhere to a standard of academic conduct, which demonstrates respect for themselves, their fellow students, and the educational mission of the University. All students are deemed by the University to understand that if they are found responsible for academic misconduct, they will be subject to the Academic Misconduct procedures and sanctions, as outlined in the Student Handbook.
More information can be found at http://academic.fiu.edu/academic_misconduct.html

Department Regulations Concerning Incomplete Grades

To qualify for an Incomplete, a student:

- Must contact (e.g., phone, email, etc.) the instructor or secretary before or during the missed portion of the class.
- Must be passing the course before that part of the course that is not completed
- Must make up the incomplete work through the instructor of the course

- Must see the Instructor. All missed work must be finished before the last two weeks of the following term.

University policies on sexual harassment, and religious holidays, and information on services for students with disabilities

- Please visit the following websites: http://academic.fiu.edu/, and http://drc.fiu.edu

Course Policies:

- **Academic Misconduct:** For work submitted, it is expected that each student will submit their original work. Any evidence of duplication, cheating, or plagiarism will result in at least a failing grade for the course.
- **Unexcused Absences:** Two unexcused absences are permitted during the term, but you need to send an email before the class to Dr. Bai, obai@fiu.edu. More than two will result in the loss of points from your final grade. (1 point per absence above two, 3 points per absence above 5).
- **Excused Absences:** Only emergency medical situations or extenuating circumstances are excused with proper documentation. After reviewing documentation, you are required to email a description of the excuse and absence dates as a written record to kaleemf@fiu.edu or obai@fiu.edu.
- **On-Time:** As in the workplace, on-time arrival and preparation are required. Two "lates" are equivalent to one absence. (Leaving class early is counted the same as tardy.)
- **Deadlines:** Assignments are due at the beginning of the class period on the date specified. Assignments submitted late (within 1 week) will receive half credit.
- To get assistance try to see me by an appointment.
- Students are encouraged to ask questions and to discuss course topics with the instructor and with each other.
- **Any work submitted should display Panther ID number and should be signed, as the students' work, and that no unauthorized help was obtained.**
- Cell phones, communicators, MP3 players, headsets are not allowed to be used in the class.
- **DO NOT** send assignments by email.
- The instructor reserves the right to change course materials or dates as necessary.

Exam policy

- Make sure to complete the assigned homework to do well in the exam.
- All exams are closed book and closed notes.
- Use of any electronic device with a keyboard is prohibited. This also applies to cellphones with the messaging system.
- No discussion is permitted during the exams.
- The instructor is not compelled to give credit for something he cannot read or follow logically.
- Cheating is considered a serious offense. Students who are caught will receive the appropriate consequences.

Class Schedule

- Refer to Course Schedule.

Special Dates to Remember

- The last day to withdraw from a course is Oct. 31, 2022
- Last day of Fall semester classes is Dec. 3, 2022
- Final Exam, undetermined/optional

Course Schedule

Week	Topics and Tasks
1 08/22	Course Syllabus and Schedule Introduction and Motivation
2 08/29	Locomotion Concepts (P.1~P.37) – Self-study Introduction to Legged Robotics Example of Wheeled, legged and Flying Robots Fundamentals of Locomotion in Legged Robotics Mobile Robots Kinematics I (P.1~P.21) Introduction to Wheeled Locomotion Homework (1)
3 09/05	Labor Day (no class) Project Preparation: Introduction to Coppelia Robotic Simulation Platform and Lua API
4 09/12	Mobile Robots Kinematics II (P.22~P.42) Differential Kinematics Wheeled Kinematics Homework (1) due on Canvas before class Project Preparation: Line Tracking Algorithms and Code Analysis Requirement for Project I: Line Tracking with Obstacles
5 09/19	Mobile Robots Kinematics III (P.43~P.49) Wheeled Mobile Robot Motion Control Perception I Sensors, (IMU, GPS) Motion Capture systems, Laser range finder, RGBD/time-of-flight/sonar Project I: Line Tracking with Obstacles (1)
6 09/26	Perception II (P.1~P.33) Introduction of Computer Vision Project I: Line Tracking with Obstacles (2)
7 10/03	Perception II (P.34~P.53) Camera Image Formation, Perspective Projection Project I: Line Tracking with Obstacles (3)

8 10/10	Perception III: Fundamentals of Image Processing (P.1~P.20) Correlation and Convolution Project I: Line Tracking with Obstacles (Performance Test and Grade)
9 10/17	Perception III: Fundamentals of Image Processing (P.21~P.91) Edges and Points Quiz I
10 10/24	Perception IV: Place Recognition & Line Fitting Place Recognition (P.1~P.18) Review of Project I & Introduction of Project II – Broken Line Tracking
11 10/31	Localization I Introduction to Map-Based Localization Project II: Broken Line Tracking (1)
12 11/07	Localization I Refresher on Probability Theory Homework (3) (both EEL3664 and EEL5669) Project II: Broken Line Tracking (2)
13 11/14	SLAM I The SLAM problem Homework (3) due on Canvas before class Project II: Broken Line Tracking (Performance Test and Grade)
14 11/21	Planning I Introduction Collision Avoidance Thanksgiving (no class)
15 11/28	Summary Quiz II
16 12/05	Final exams (undetermined/optional)

- Homework is due before next Monday class