

University of Texas at Arlington – Spring 2015

CSE 4360/5364 **Autonomous Robots**

Class Schedule:

Mon. & Wed., 4:00-5:20pm; SH 331
<http://www.uta.edu/chemistry/about/buildings.php>

Office Hours:

Mon. & Wed., 2:00-3:30pm or by appointment

Course Website:

<http://ranger.uta.edu/~gianluca/teaching/CSE4360-5364/>

Faculty:

Dr. Gian Luca Mariottini

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Office:

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Arlington, TX 76019-0015

Course Overview:

Human being always looked for substitutes that would mimic their behavior to perform repetitive and dangerous operations. In the past few years Robotics has witnessed an impressive and revolutionary technological growth and robots are now successfully employed in a wealth of industrial, social and aerospace applications.

In this course, students will be introduced to the basics of Robotics and will learn about robot kinematics, dynamics, and control, as well as motion planning, sensors, and probabilistic reasoning for robot estimation (such as localization and mapping). All of these tools and algorithms will allow the students to discover and truly understand what is behind such a rapid growth, and will give answers to questions like: how can a robot perceive its surroundings? How can a robot autonomously move in an environment while avoiding obstacles?

Throughout the course, students will work individually and in groups to learn core concepts of robotics, to analyze robotics problems and to design software solutions for the above problems. After successfully completing this course, students will be able to understand, analyze and master a variety of techniques and algorithms in robot navigation, sensing and control.

Course Prerequisites:

- Prerequisites include CSE 2320 and CSE 3442.
- Matlab programming experience is strongly recommended. If you are unfamiliar, please check this: <http://www.math.ucsd.edu/~bdriver/21d-s99/matlab-primer.html>.
- Python or C/C++ programming experience can be beneficial for the final project.
- Feel free to contact the advisor in case you have specific questions.

Course Goals:

CSE 4360/5364 is designed to:

- Introduce the student to fundamentals of robotics, robot control, and sensing.
- Explore the mathematical/algebraic foundations of robot kinematics, control and localization.
- Explore and familiarize with robot planning and navigation techniques.

Course Outcomes:

Upon successful completion of the course, each student will be able to:

- Recognize the features and peculiarities of different robotic devices.
- Understand rigid body kinematics and relationships between 3-D reference frames.
- Describe direct and inverse kinematics.
- Compare the characteristics of different sensing devices (encoders, pinhole and stereo cameras, etc.).

- Understand and implement motion planning algorithms.
- Understand and discuss different algorithms for robot localization and mapping.

Course topics:

- Intro to Robot Systems
- Robot Kinematics
- Inverse Kinematics
- Motion Planning and Trajectory Generation
- Linear Control of Manipulators
- Sensors for Robotics
- Mobile Robots
- Probabilistic Approaches to Robot Localization
- Kalman Filter (KF) and Extended-KF
- Robot Localization and Mapping

(please note that these course topics are preliminary and might undergo slight changes)

Tentative Schedule

		Teaching topic
January	21	Introduction to Robotics
	26	Robotic Structures
	28	Spatial Descriptions & Transform. 1/3
February	2	Spatial Descriptions & Transform. 2/3
	4	Spatial Descriptions & Transform. 3/3
	9	Kinematic: Forward & Inverse 1/3
	11	Kinematic: Forward & Inverse 2/3
	16	Kinematic: Forward & Inverse 3/3
	18	<i>Intro to Python on EV3</i>
	23	<i>Intro to Python on EV3</i>
March	25	Path Planning and Trajectory Generat.
	2	Path Planning and Trajectory Generat.
	4	Project Assignment
	9	Spring Break
	11	Spring Break
	16	<u>Project #1 - Presentation</u>
	18	Robot Control
	23	Robot Control
	25	Robot Control
	30	Mobile Robots
April	1	Mobile Robots
	6	Sensors
	8	Sensors
	13	Sensors
	15	<i>Intro to OpenCV</i>
	20	<i>Intro to OpenCV</i>
	22	Introduction to localization
	27	Introduction to localization
	29	Introduction to localization
May	4	<u>Project #2 - Presentation</u>
	6	<u>Project #2 - Presentation</u>

Course text:

There is no required textbook for this course. Students are strongly encouraged to attend class and take notes during class time. However, selected parts of other textbooks (see list below) will be used as part of the course readings. Copies of these material will be put on reserve in the Science and Engineering Library.

- John J. Craig
"Introduction to Robotics: Mechanics and Control", Addison Wesley, 2004
- B. Siciliano, L. Sciavicco, L. Villani, G. Oriolo
"Robotics: Modelling, Planning and Control", 3rd Edition, Springer, 2009
- Jean-Claude Latombe
"Robot Motion Planning", Kluwer Academic Publishers
- R. Cipolla
"Computer Vision and Robotics", Cambridge University, UK (on-line course material)
- Y. Ma, S. Soatto, J. Kosecka, S. Sastry
"An Invitation to 3-D Vision. From Images to Geometric Models", Springer 2003

Office Hours

The instructor is generally available before or after class and by appointment, as well as at the office hours scheduled above.

Course Assignments, Exams and Policies

Class attendance and participation

In CSE 4360/5364, the students will be presented with the state-of-the-art of robotics.

I strongly encourage the students to attend each class, to take notes of in-class presentation, and to actively contribute with in-class discussion, when necessary. Students must arrive on time at class.

During the whole semester, I like to interact with the participants and ask them to actively participate to complete informal small in-class exercises. These informal activities will not be graded but will be used as a feedback or plan activities.

Homeworks and Course Project

Students will be graded based on 3 homework assignments and 2 projects. The assignments will consist of written parts as well as programming exercises in MATLAB. Dates for the homeworks will be announced in class. Regarding homeworks policies, please refer also to the Course Policy section. For students enrolled in the graduate section CSE 5364 the homework assignments, as well as the course project, will contain additional problems, which are not required for students of CSE 4360.

For the projects, a list will be provided in class. Groups of max. 2 students will be formed; each project will involve designing and implementing a particular algorithm on a real robotic system. We have quite a few (Parrot drones, iCreate, Lego EV3). At the end of each project, the programmed robot system has to be presented, together with a project report (5-8 pages) describing the design and implementation details. For the 2nd project, additional project ideas related to the course topics may be proposed by students: this will require approval by the instructor, based upon the content of a project abstract submitted by each group (mandatory submission before a deadline, to be announced in class). In evaluating the projects design, particular attention will be given to the projects that excel

in creativity and effectiveness of their result.

Grading policy

Tentatively, course grades will be based on the following

Assignments	% of final grade	Percent Grade
Homework assignments (total)	40 %	90% - 100% A
Course Project 1	20 %	80% - 89.9% B
Course Project 2	40 %	70% - 79.9% C
		60% - 69.9% D
		< 60% F

Final Project/Homework Late Submission Policy

Late submissions for the *final project* and *homeworks* will be penalized according to:

- Late by 1-24 hrs: 5% deducted from actual score.
- Late by 24-48 hrs: 50% deducted from actual score.
- Late by more than 48 hrs: Will receive a zero.

University Policies and Services

Course/University Policies and Services

Attendance

At The University of Texas at Arlington, taking attendance is not required. Rather, each faculty member is free to develop his or her own methods of evaluating students' academic performance, which includes establishing course-specific policies on attendance. As the instructor of this section, I will not take attendance.

However, as stated above, attendance is strongly suggested at the first day and each class session. Students are encouraged to arrive on time and attend the full class period.

Participants who need to miss class for religious observance or for a pressing personal or family matter, should contact the instructor prior to missing class or as soon as possible. Participants should plan on getting the information about the missed class from a peer.

I strongly encourage in-class collegial behaviour as well as between the project group members. Non-collegial behavior includes working on other tasks during class time (text messaging, e-mailing, Web surfing, doing crosswords/Sudoku, having private conversations, etc.). Another example of non-collegial behavior could be the creation of unconstructive conflicts inside a group.

Finally, I positively value the students' active participation to in-class discussions. This is extremely important because gives the instructor (and the students too!) a feedback on the audience understanding.

Drop Policy:

Students may drop or swap (adding and dropping a class concurrently) classes through self-service in MyMav from the beginning of the registration period through the late registration period. After the late registration period, students must see their academic advisor to drop a class or withdraw. Undeclared students must see an advisor in the University Advising Center. Drops can continue through a point two-thirds of the way through the term or session. It is the student's responsibility to officially withdraw if they do not plan to attend after registering. **Students will not be automatically dropped for non-attendance.** Repayment of certain types of financial aid administered through the University may be required as the result of dropping classes or withdrawing. For more information, contact the Office of Financial Aid and Scholarships (<http://www.uta.edu/aao/fao/>).

Americans with Disabilities Act:

The University of Texas at Arlington is on record as being committed to both the spirit and letter of all federal equal opportunity legislation, including the Americans with Disabilities Act (ADA). All instructors at UT Arlington are required by law to provide "reasonable accommodations" to students with disabilities, so as not to discriminate on the basis of that disability. Any student requiring an accommodation for this course must provide the instructor with official documentation in the form of a letter certified by the staff in the Office for Students with Disabilities, University Hall 102. Only those students who have officially documented a need for an accommodation will have their request honored. Information regarding diagnostic criteria and policies for obtaining disability-based academic accommodations can be found at www.uta.edu/disability or by calling the Office for Students with Disabilities at (817) 272-3364.

Title IX:

The University of Texas at Arlington is committed to upholding U.S. Federal Law "Title IX" such that no member of the UT Arlington community shall, on the basis of sex, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any education program or activity. For more information, visit www.uta.edu/titleIX.

Academic Integrity:

Students enrolled all UT Arlington courses are expected to adhere to the UT Arlington Honor Code:

I pledge, on my honor, to uphold UT Arlington's tradition of academic integrity, a tradition that values hard work and honest effort in the pursuit of academic excellence.

I promise that I will submit only work that I personally create or contribute to group collaborations, and I will appropriately reference any work from other sources. I will follow the highest standards of integrity and uphold the spirit of the Honor Code.

UT Arlington faculty members may employ the Honor Code as they see fit in their courses, including (but not limited to) having students acknowledge the honor code as part of an examination or requiring students to incorporate the honor code into any work submitted. Per UT System Regents' Rule 50101, §2.2, suspected violations of university's standards for academic integrity (including the Honor Code) will be referred to the Office of Student Conduct. Violators will be disciplined in accordance with University policy, which may result in the student's suspension or expulsion from the University.

Electronic Communication:

UT Arlington has adopted MavMail as its official means to communicate with students about important deadlines and events, as well as to transact university-related business regarding financial aid, tuition, grades, graduation, etc. All students are assigned a MavMail account and are responsible for checking the inbox regularly. There is no additional charge to students for using this account, which remains active even after graduation. Information about activating and using MavMail is available at <http://www.uta.edu/oit/cs/email/mavmail.php>.

Student Feedback Survey:

At the end of each term, students enrolled in classes categorized as "lecture," "seminar," or "laboratory" shall be directed to complete an online Student Feedback Survey (SFS). Instructions on how to access the SFS for this course will be sent directly to each student through MavMail approximately 10 days before the end of the term. Each student's feedback enters the SFS database anonymously and is aggregated with that of other students enrolled in the course. UT Arlington's effort to solicit, gather, tabulate, and publish student feedback is required by state law; students are strongly urged to participate. For more information, visit <http://www.uta.edu/sfs>

Final Review Week:

A period of five class days prior to the first day of final examinations in the long sessions

shall be designated as Final Review Week. The purpose of this week is to allow students sufficient time to prepare for final examinations. During this week, there shall be no scheduled activities such as required field trips or performances; and no instructor shall assign any themes, research problems or exercises of similar scope that have a completion date during or following this week *unless specified in the class syllabus**. During Final Review Week, an instructor shall not give any examinations constituting 10% or more of the final grade, except makeup tests and laboratory examinations. In addition, no instructor shall give any portion of the final examination during Final Review Week. During this week, classes are held as scheduled. In addition, instructors are not required to limit content to topics that have been previously covered; they may introduce new concepts as appropriate.

** The policy on final review week might change for this class. Students will be informed by email ahead of time.*

Emergency Exit Procedures:

Should we experience an emergency event that requires us to vacate the building, students should exit the room and move toward the nearest exit. When exiting the building during an emergency, one should never take an elevator but should use the stairwells. Faculty members and instructional staff will assist students in selecting the safest route for evacuation and will make arrangements to assist individuals with disabilities.

Student Support Services:

UT Arlington provides a variety of resources and programs designed to help students develop academic skills, deal with personal situations, and better understand concepts and information related to their courses. Resources include tutoring, major-based learning centers, developmental education, advising and mentoring, personal counseling, and federally funded programs. For individualized referrals, students may visit the reception desk at University College (Ransom Hall), call the Maverick Resource Hotline at 817-272-6107, send a message to resources@uta.edu, or view the information at www.uta.edu/resources