COURSE DISCIPLINE : CS/IS

COURSE NUMBER : 157

COURSE TITLE (FULL) : Robot Motion Planning

COURSE TITLE (SHORT) : Robot Motion Planning

CATALOG DESCRIPTION

CS/IS 157 provides an introduction to the art and practice of programming mobile robots using modern programming language(s) such as C++, Java or Python. It uses the context of robot programming to develop skills in software development. Students gain experience specifying open-loop and feedback behaviors, handling RGB input video, range images, tactile sensing, and other robot sensors, and reasoning about the spatial context of navigation and localization tasks. The vast majority of the course experience consists of implementation of and experimentation with these skills through hands-on labs.

Total Lecture Units: 2.00

Total Laboratory Units: 1.00

Total Course Units: 3.00

Total Lecture Hours: 36.00

Total Laboratory Hours: 54.00

Total Laboratory Hours To Be Arranged: 0.00

Total Contact Hours: 90.00

Total Out-of-Class Hours: 72.00

Recommended Preparation: CS/IS 135.

ENTRY STANDARDS

	Subject	Number	Title	Description	Include
1	CS/IS	135	Programming In C/C++	analyze a programming task to develop and communicate efficient algorithms to implement that task;	Yes
2	CS/IS	135	Programming In C/C++	recognize programming problems on a function-by-function basis and develop structured/procedural code based on this approach;	No
3	CS/IS	135	Programming In C/C++	demonstrate an understanding of object-oriented programming concepts and object-oriented design;	No
4	CS/IS	135	Programming In C/C++	program in the C++ language including use of objects, pointers, and structures.	No
5				design, code, and debug basic object-based programs;	No

EXIT STANDARDS

1. design and implement programs that solve algorithmic and robotic problems;
2. write software that will control a mobile robot to complete navigation tasks successfully, including the integration of sensing, sensor-data processing, and robot action;
3. articulate and mitigate the challenges that distinguish robot programming both from the human performance of tasks and from programmatic solutions to non-robotic tasks.

STUDENT LEARNING OUTCOMES

1. implement ground-platform and aerial platform robotic programming;
2. write code that will enable a mobile robot to handle tasks successfully with the use of sensors and motion;
3. translate human tasks into code for mobile robotics.

COURSE CONTENT WITH INSTRUCTIONAL HOURS

	Description	Lecture	Lab	Total Hours
1	Programming Robot Motions/Actuation • Ground-platform programming • Differential-drive geometry and constraints • Arcade-style vs. individual-wheel control • Aerial platform programming • Strategies for stabilizing motions • Holonomic robot control • Control techniques • Open-loop control • Direct-feedback control (servoing) • State-machine control	11	17	28

2	Processing Sensor Data • Infrared data (e.g. for line-following or single-range sensing) • Tactile (bump) sensing • RGB video data • Color spaces and color definitions • Region segmentation and image morphology • Statistical summaries: center of mass and bounding box • Range image data • 2d and 3d estimation of planar surface/wall geometry • Handling angles without a privileged coordinate system • 2d segmentation of 3d range data	11	17	28
3	Robotic Spatial Reasoning • Designing robot tasks through purely reactive control • Using state machines to add context to robot tasks • Implementing navigation algorithms • Using human-specified destinations • Using sensor-specified destinations • Robust motion planning to handle environmental uncertainty • Implementing localization algorithms • Environment-specific localization • Monte Carlo techniques for localization	14	20	34
				90

OUT OF CLASS ASSIGNMENTS

1 individual and/or group project (e.g. develop and deploy software solutions to solve robot challenges).

METHODS OF EVALUATION

1 quizzes;
2 midterm examinations;
3 performance-based assessment of student-written programs;
4 instructor evaluation of student portfolio work;
5 final examination.

METHODS OF INSTRUCTION

- [x] Lecture
- [x] Laboratory
- [ ] Studio
- [ ] Discussion
- [ ] Multimedia
- [ ] Tutorial
- [ ] Independent Study
- [ ] Collaboratory Learning
- [x] Demonstration
- [ ] Field Activities (Trips)
- [ ] Guest Speakers
- [ ] Presentations

TEXTBOOKS

Title	Type	Publisher	Edition	Medium	Author	IBSN	Date
Introduction to Autonomous Robots: Kinematics, Perception, Localization, and Plannin	Required	Cambridge: MIT P			Correll, Nikolaus	978-069270087 7	2020