CS/IS157 : Robot Motion Planning

General Information

Author:	• Tony Biehl
Course Code (CB01) :	CS/IS157
Course Title (CB02) :	Robot Motion Planning
Department:	CSIS
Proposal Start:	Spring 2025
TOP Code (CB03) :	(0707.00) Computer Software Development
CIP Code:	(11.0201) Computer Programming/Programmer, General.
SAM Code (CB09) :	Possibly Occupational
Distance Education Approved:	No
Will this course be taught asynchronously?:	No
Course Control Number (CB00) :	CCC000545406
Curriculum Committee Approval Date:	05/08/2024
Board of Trustees Approval Date:	06/18/2024
Last Cyclical Review Date:	05/08/2024
Course Description and Course Note:	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 red/green/blue (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.
Justification:	Mandatory Revision
Academic Career:	• Credit
Author:	• Tony Biehl

Academic Senate Discipline

Primary Discipline:	• Computer Science
Alternate Discipline:	• Computer Information Systems (Computer network installation, microcomputer technology, computer applications)
Alternate Discipline:	No value

Course Development

Basic Skill Status (CB08)

Course is not a basic skills course.

☐ Allow Students to Gain Credit by Exam/Challenge

Course Special Class Status (CB13)

Course is not a special class.

Pre-Collegiate Level (CB21)

Not applicable.

Grading Basis

- Grade with Pass / No-Pass Option

Course Support Course Status (CB26)

Course is not a support course

Transferability & Gen. Ed. Options

General Education Status (CB25)

Not Applicable

Transferability

Transferable to CSU only

Transferability Status

Approved

Units and Hours

Summary

Minimum Credit Units (CB07)	3
Maximum Credit Units (CB06)	3
Total Course In-Class (Contact) Hours	90
Total Course Out-of-Class Hours	72
Total Student Learning Hours	162

Credit / Non-Credit Options

Course Type (CB04)

Credit - Degree Applicable

Noncredit Course Category (CB22)

Credit Course.

Noncredit Special Characteristics

No Value

Course Classification Code (CB11)

Credit Course.

Funding Agency Category (CB23)

Not Applicable.

☐ Cooperative Work Experience Education Status (CB10)

☐ Variable Credit Course

Weekly Student Hours

	In Class	Out of Class
Lecture Hours	2	4
Laboratory Hours	3	0
Studio Hours	0	0

Course Student Hours

Course Duration (Weeks)	18
Hours per unit divisor	54
Course In-Class (Contact) Hours	
Lecture	36
Laboratory	54
Studio	0

Total	90

Course Out-of-Class Hours

Lecture	72
Laboratory	0
Studio	0
Total	72

Time Commitment Notes for Students

No value

Units and Hours - Weekly Specialty Hours

Activity Name	Type	In Class	Out of Class
No Value	No Value	No Value	No Value

Pre-requisites, Co-requisites, Anti-requisites and Advisories

Advisory

CS/IS135 - Programming In C/C++

Objectives

- Recognize programming problems on a function-by-function basis and develop structured/procedural code based on this approach.
- Demonstrate an understanding of object-oriented programming concepts and object-oriented design in creating a program.
- Program in the C++ language including use of objects, pointers, and structures.

Entry Standards

Entry Standards

Analyze a programming task to develop and communicate efficient algorithms to implement that task.

Design, code, and debug basic object-based programs.

Course Limitations

Cross Listed or Equivalent Course

Specifications

Methods of Instruction

Methods of Instruction	Lecture
Methods of Instruction	Laboratory
Methods of Instruction	Demonstrations

Out of Class Assignments

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

Methods of Evaluation	Rationale
Exam/Quiz/Test	Final examination
Exam/Quiz/Test	Quizzes
Exam/Quiz/Test	Midterm examinations
Exam/Quiz/Test	Performance-based assessment of student-written programs
Exam/Quiz/Test	Instructor evaluation of student portfolio work

Textbook Rationale

No Value

Textbooks

Author	Title	Publisher	Date	ISBN
Correll, Nikolaus	Introduction to Autonomous Robots: Kinematics, Perception, Localization, and Plannin	Cambridge: MIT P	2020	978-0692700877

Other Instructional Materials (i.e. OER, handouts)

No Value

Materials Fee

No value

Learning Outcomes and Objectives

Course Objectives

Design and implement programs that solve algorithmic and robotic problems.

Write software that will control a mobile robot to complete navigation tasks successfully, including the integration of sensing, sensor-data processing, and robot action.

Articulate and mitigate the challenges that distinguish robot programming both from the human performance of tasks and from programmatic solutions to non-robotic tasks.

SLOs

Implement ground-platform and aerial platform robotic programming. Expected Outcome Performance: 70.0

ILOs Core ILOs	Analyze and solve problems using critical, logical, and creative thinking; ask questions, pursue a line of inquiry, and derive conclusions; cultivate creativity that leads to innovative ideas.
	Demonstrate depth of knowledge in a course, discipline, or vocation by applying practical knowledge, skills, abilities, theories, or methodologies to solve unique problems.
CSIS Computer Science - A.S. Degree Major	Prepare a software project to implement a single scientific, mathematical, business, or technical function.
CSIS Computer Science - Certificate	Prepare a software project to implement a single scientific, mathematical, business, or technical function.
CSIS Computer Software Technician	demonstrate the ability to independently create, save, modify and print a document using a word processing program and appropriate assistive technology
CSIS Web Development - Certificate	use industry standard tools and techniques to produce, publish and maintain Web sites and Web content.
CSIS Web Development - A.S. Degree Major	use industry standard tools and techniques to produce, publish and maintain Web sites and Web content.

Write code that will enable a mobile robot to handle tasks successfully with the use of sensors and motion. Expected Outcome Performance: 70.0

ILOs Core ILOs	Analyze and solve problems using critical, logical, and creative thinking; ask questions, pursue a line of inquiry, and derive conclusions; cultivate creativity that leads to innovative ideas.
	Demonstrate depth of knowledge in a course, discipline, or vocation by applying practical knowledge, skills, abilities, theories, or methodologies to solve unique problems.
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CSIS Computer Software Technician	demonstrate the ability to independently create, save, modify and print a document using a word processing program and appropriate assistive technology
CSIS Web Development - A.S. Degree Major	use industry standard tools and techniques to produce, publish and maintain Web sites and Web content.
CSIS Web Development - Certificate	use industry standard tools and techniques to produce, publish and maintain Web sites and Web content.

Translate human tasks into code for mobile robotics. Expected Outcome Performance: 70.0

ILOs Core ILOs	Analyze and solve problems using critical, logical, and creative thinking; ask questions, pursue a line of inquiry, and derive conclusions; cultivate creativity that leads to innovative ideas.
	Demonstrate depth of knowledge in a course, discipline, or vocation by applying practical knowledge, skills, abilities, theories, or methodologies to solve unique problems.
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Additional SLO Information

Does this proposal include revisions that might improve student attainment of course learning outcomes?

No

Is this proposal submitted in response to learning outcomes assessment data?

No

If yes was selected in either of the above questions for learning outcomes, explain and attach evidence of discussions about learning outcomes.

No Value

SLO Evidence

No Value

Course Content

Lecture Content

Programming Robot Motions/Actuation (11 hours)

- 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

Processing Sensor Data (11 hours)
- Infrared data (e.g. for line-following or single-range sensing)
- Tactile (bump) sensing
- Red, green, and blue (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

Robotic Spatial Reasoning (14 hours)
- 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

Total hours: 36

Laboratory/Studio Content

Programming Robot Motions/Actuation (17 hours)
- 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

Processing Sensor Data (17 hours)
- Infrared data (e.g. for line-following or single-range sensing)
- Tactile (bump) sensing
- Red, green, and blue (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

Robotic Spatial Reasoning (20 hours)
- 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

Total hours: 54

Additional Information

Is this course proposed for GCC Major or General Education Graduation requirement? If yes, indicate which requirement in the two areas provided below.

No

GCC Major Requirements

No Value

GCC General Education Graduation Requirements

No Value

Repeatability

Not Repeatable

Justification (if repeatable was chosen above)

No Value

Resources

Did you contact your departmental library liaison?

No

If yes, who is your departmental library liason?

No Value

Did you contact the DEIA liaison?

No

Were there any DEIA changes made to this outline?

No

If yes, in what areas were these changes made:

No Value

Will any additional resources be needed for this course? (Click all that apply)

- No

If additional resources are needed, add a brief description and cost in the box provided.

No Value