Knight Foundation School of Computing and Information Sciences

Course Title: Introduction to Mobile Robotics **Date:** 09/23/2015

Course Number: CDA 4625

Number of Credits: 3

Subject Area: Foundations	**Subject Area Coordinator: Gr**egory Reis **email:** gmuradre@fiu.edu
Catalog Description: A first course on the theoretical and practical aspects of mobile robotics. Topics include locomotion, kinematics, sensing and perception, localization and mapping, planning and navigation.	
Textbook: Introduction to Autonomous Mobile Robots (second edition), Roland Siegwart, Illah R. Nourbakhsh and Davide Scaramuzza. Bradford Books, 2011. ISBN: 0262015358	
References: The Robotics Primer, Maja. J. Mataric, MIT Press, 2007. ISBN 9780262633543 Planning Algorithms Steven. M. LaValle, Cambridge University Press, 2006. ISBN 0521862051 Principles of Robot Motion, Howie Choset, et al. ISBN 0-262-03327-5.	
Prerequisites Courses: COP 3530 and STA 3033	
Corequisites Courses: None	

Type: Elective for CS (Systems group)

Prerequisites Topics:

1. Basic techniques of algorithm runtime analysis
2. Graph algorithms such as shortest path and minimum spanning tree
3. Knowledge of a standard data structure library of a major programming language
4. Familiarity with basic probability concepts
5. Familiarity with discrete and continuous probability functions

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Course Outcomes:

1. List capabilities and limitations of today's state-of-the- art robot systems, including their sensors and the crucial sensor processing that informs those systems [Familiarity]
2. Integrate sensors, actuators, and software into a robot designed to undertake some task. [Usage]
3. Summarize the importance of image and object recognition in AI and indicate several significant applications of this technology. [Familiarity]
4. List at least three image- segmentation approaches, such as thresholding, edge-based and region-based algorithms, along with their defining characteristics, strengths, and weaknesses [Familiarity]
5. Characterize the uncertainties associated with common robot sensors and actuators; articulate strategies for mitigating these uncertainties. [Familiarity]
6. List the differences among robots' representations of their external environment, including their strengths and shortcomings. [Familiarity]
7. Implement fundamental motion planning algorithms within a robot configuration space. [Usage]
8. Compare and contrast at least three strategies for robot navigation within known and/or unknown environments, including their strengths and shortcomings [Assessment]

Assessment Plan for the Course & how Data in the Course are used to assess Program Outcomes

Student and Instructor Course Outcome Surveys are administered at the conclusion of each offering, and are evaluated as described in the School's Assessment Plan: https://abet.cs.fiu.edu/csassessment/

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Introduction to Mobile Robotics

Outline

Topic	Number of Lecture Hours	Outcome
• Introduction o Motivation o Domains of applications o Types of mobile robots o Problems in mobile robotics	2	1
• Locomotion o Important issues for locomotion o Legged Mobile robots o Wheeled Mobile robots o Aerial Mobile robots	4	1,2,5
• Mobile Robot Kinematics o Kinematic Models and Constrains o Mobile Robot Maneuverability o Mobile Robot Workspace o Motion Control	4	1,2,5
• Perception o Sensors for mobile robots o Fundamentals of Image Processing o Fundamentals of Computer Vision o Feature Extraction	6	3,4,5
• Mobile Robot Localization o Challenges of Localization o Belief Representation o Probabilistic Map-Based Localization o Other Localization Systems	8	6
• Planning and Navigation o Planning and reacting o Path Planning o Obstacle Avoidance o Navigation Architectures	12	7,8

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Course Outcomes Emphasized in Laboratory Projects / Assignments

	Outcome	Number of Weeks
1	Locomotion Outcome:1,2	1
2	Mobile Robot Kinematics Outcomes: 2,5	1
3	Perception Outcomes: 3,4	1
4	Mobile Robot Localization Outcomes: 6	1
5	Planning and Navigation Outcomes: 7,8	1

Oral and Written Communication:

Written Reports	Oral Presentations		
Number Required	Approx. Number of pages	Number Required	Approx. Time for each
1	4	1	15 minutes

Social and Ethical Implications of Computing Topics

No significant coverage

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Approximate number of credit hours devoted to fundamental CS topics

Topic	Core Hours	Advanced Hours
Algorithms:		**2.0**
Software Design:		
Computer Organization and Architecture:		**1.0**
Data Structures:		
Concepts of Programming Languages		

Theoretical Contents

Topic	Class time
Statistics and Linear algebra	2.0

Problem Analysis Experiences

1.	Identify problems that can be solved by using mobile robots.

Solution Design Experiences

1.	Locomotion
2.	Mobile Robot Kinematics
3.	Perception
4.	Mobile Robot Localization
5.	Planning and Navigation

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Introduction to Mobile Robotics

The Coverage of Knowledge Units within Computer Science Body of Knowledge[1]

Knowledge Area	Knowledge Unit	Lecture Hours		
		Tier-1	Tier-2	Elective
IS	Robotics			30
IS	Perception and Computer Vision			6

[1]See Appendix A in *Computer Science Curricula 2013.* Final Report of the IEEE and ACM Joint Task Force on Computing Curricula, available at: https://www.acm.org/binaries/content/assets/education/cs2013_web_final.pdf