Computer Science Department
cs.salemstate.edu

CSC 485 Robotics and Computer Vision **4 cr.**

Instructor: TBA **Office:** location **Phone:** (978) 542-extension
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Section	Time	Room	Final Exam
nn	days and times	location	date and time
Lnn	days and times	location	

Catalog description:

This course presents the basic science behind mobile robotics, robotic manipulation, and computer vision. The course examines key aspects of autonomous systems including sensors, map making, and path planning. The fundamentals of robotic manipulation will be presented, including coordinate transformations, manipulator kinematics, and motion. Topics in computer vision include image formation and sensing, region and edge extraction, feature identification, camera calibration, and optical measurement. The course concludes with techniques for integrating vision, mobile robots, and manipulators into a complete system. Three hours of lecture and three hours of scheduled laboratory time per week.

Prerequisite: CSC 260; CSC 279 strongly recommended.

Course Goals:

The purpose of this course is to:

CG01: develop an understanding of image sensing and processing;
CG02: understand the fundamental mathematics behind robot kinematics and dynamics;
CG03: present a unified description of sensing, path planning, and motion for autonomous systems;
CG04: present a consistent methodology for describing manipulator kinematics and motion;
CG05: present design methods for integrated robotic systems.

Course Objectives:

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

CO01: develop software for basic computer vision tasks;
CO02: identify key sensors and their roles in autonomous systems;
CO03: describe basic path planning algorithms;
CO04: analyze the structure of a simple robotic manipulator;
CO05: describe basic motion algorithms;
CO06: identify strategies for integrating vision, autonomous systems, and manipulators into a complete system;
CO07: produce clear documentation for problems assigned in the course and their solutions.

Program Outcome vs. Course Objectives matrix

Program Objective (condensed form)	CO01	CO02	CO03	CO04	CO05	CO06	CO07
PO-A: apply knowledge of computing and math	✓	✓	✓	✓	✓	✓	✓
PO-B: analyze a problem and define its computing requirements	✓	✓	✓	✓	✓	✓	✓
PO-C: design, implement and evaluate applications	✓						
PO-D: function effectively in teams to accomplish a common goal							
PO-E: professional, ethical, and social responsibilities							

Program Objective (condensed form)	CO01	CO02	CO03	CO04	CO05	CO06	CO07
PO-F: communicate effectively with a range of audiences							✓
PO-G: local and global impact of computing on people and society							
PO-H: need for continuing professional development							
PO-I: use current techniques, skills, and tools	✓	✓	✓	✓	✓	✓	✓
PO-J: apply theory and principles to model and design systems		✓	✓	✓	✓	✓	
PO-K: apply design and development principles in constructing software							
note - full statements of the **P**rogram **O**utcomes (objectives) for the Computer Science Major can be found in the document *Computer Science Major Program Educational Objectives and Program Outcomes* on the Assessment page of the Computer Science Major (cs.salemstate.edu)							

Topics: **(Total available class lecture hours: 42)**

- Autonomous Mobile Robotics **IS5(2), IS10 (10)**
  - Kinematic Models
  - Perception and sensing for mobile robots
  - Localization, belief representation, maps
  - Path planning
- Robotic Manipulation **IS10 (12)**
  - Coordinate transformations
  - Kinematic Equations
  - Manipulator configurations: planar, Cartesian, linear, and parallel
  - Joint and Cartesian motion
- Computer Vision **GV11 (12)**
  - Image formation and sensing
  - Regions and image segmentation
  - Edges and edge finding
  - Color and color processing
  - Camera calibration and optical measurement
- Systems Integration **AR9(2)**
  - Integration of sensing, motion, manipulation
  - Network architectures for distributed robotics
  - Representative systems

Assignments: Six to eight homework assignments will be given to reinforce learning of the mathematics and algorithms behind vision, map making, path planning, and manipulation. Four to six laboratory programming assignments will be given in three of the major areas of the course: vision processing, mobile robot navigation, and manipulation of objects.

Quizzes, Tests and Examinations: There will be two examinations plus a comprehensive final exam that will be administered during the final exam period.

Grading: The final grades will be determined according to the formula: final 20%, hour exams 15% each, laboratory work 30%, homework 20%.

Course Objective / Assessment Mechanism matrix

	Homework Assignments	Tests	Labs	Final Examination
CO01	✓	✓	✓	✓
CO02	✓	✓	✓	✓
CO03	✓	✓	✓	✓

	Homework Assignments	Tests	Labs	Final Examination
CO04	✓	✓	✓	✓
CO05	✓	✓	✓	✓
CO06	✓	✓	✓	✓
CO07	✓		✓	

Bibliography:

Bradski, Gary, Kaehler, Adrian **Learning OpenCV: Computer Vision with the Open CV Library**, O'Reilly, 2008.
Brauni, T. Embedded Robotics: Mobile Robot Design and Application with Embedded Systems, Springer, 2008.
Davies, E. R. **Machine Vision: Theory, Algorithms, Practicalities**, Elsevier, 2005.
Forsyth, David A., Ponce, Jean. **Computer Vision: A Modern Approach.** Prentice Hall, 2002.
Horn, Berthold; Horn, Klaus Paul. **Robot Vision.** MIT Press, 1986.
Jazar, Reza N. **Theory of Applied Robotics: Kinematics, Dynamics and Control**. Springer, 2007.
Parker, J. R. **Algorithms for Image Processing and Computer Vision**, 2nd ed., Wiley, 2010.
Paul, Richard P. **Robot Manipulators: Mathematics, Programming, and Control**. MIT Press, 1981.
Sciavicco, L., Siciliano, B. **Modelling and Control of Robot Manipulators**, Springer, 1996.
Siegwart, Roland; Nourbakhsh, Illah R., Scaramuzza, Davide, **Introduction to Autonomous Mobile Robots**. MIT Press, 2011.

Academic Integrity Statement:

"Salem State University assumes that all students come to the University with serious educational intent and expects them to be mature, responsible individuals who will exhibit high standards of honesty and personal conduct in their academic life. All forms of academic dishonesty are considered to be serious offences against the University community. The University will apply sanctions when student conduct interferes with the University primary responsibility of ensuring its educational objectives." Consult the University catalog for further details on Academic Integrity Regulations and, in particular, the University definition of academic dishonesty.

The Academic Integrity Policy and Regulations can be found in the University Catalog and on the University website (http://catalog.salemstate.edu/content.php?catoid=13&navoid=1295#Academic_Integrity). The formal regulations are extensive and detailed - familiarize yourself with them if you have not previously done so. A concise summary of and direct quote from the regulations: "Materials (written or otherwise) submitted to fulfill academic requirements must represent a student's own efforts". *Submission of other's work as one's own without proper attribution is in direct violation of the University's Policy* and will be dealt with according to the University's formal Procedures. *Copying without attribution is considered cheating in an academic environment - simply put,* ***do not do it!***

University-Declared Critical Emergency Statement:

In the event of a university-declared emergency, Salem State University reserves the right to alter this course plan. Students should refer to www.salemstate.edu for further information and updates. The course attendance policy stays in effect until there is a university-declared critical emergency.

In the event of an emergency, please refer to the alternative educational plans for this course, which will be distributed via standing class communication protocols. Students should review the plans and act accordingly. Any required material that may be necessary will have been previously distributed to students electronically or will be made available as needed via email and/or Internet access.

Equal Access Statement:

"Salem State University is committed to providing equal access to the educational experience for all students in compliance with Section 504 of The Rehabilitation Act and The Americans with Disabilities Act and to providing all reasonable academic accommodations, aids and adjustments. **Any student who has a documented disability requiring an accommodation, aid or adjustment should speak with the instructor immediately.** Students with Disabilities who have not previously done so should provide documentation to and schedule an appointment with the Office for Students with Disabilities and obtain appropriate services."

Note: This syllabus represents the intended structure of the course for the semester. If changes are necessary, students will be notified in writing and via email.