CS 33302: Intro To Intelligent Robotics

Department of Computer Science

Monday and Wednesday from 09:15 AM to 10:30 AM
Credit: 3

Course Outline and Objectives:

Robots are increasingly deployed in areas inaccessible to humans to address labor shortages, enhance precision, and optimize cost-effective manufacturing processes. They are vital in monitoring, space exploration, precision surgery, and providing artificial limb support for the elderly and physically challenged. Computer science plays a crucial role in robotics, encompassing algorithms, artificial intelligence, and image processing, all essential for robotic functionality.
This course aims to provide fundamental knowledge of robotic systems, covering modeling, design, planning, and control. It includes an introduction to the intrinsic geometry, kinematics, statics, mechanics, and controls of robotic systems, along with practical examples and performance outcomes.
This course will be 60% hands-on lab and 40% theoretical study, where you will design and build custom robots from the ground up

Learning Outcomes:

Students completing this course will

- ☐ Learn the evolution of robotics and modern happenings in robotics technology
- ☐ Become familiar with the terminology of robotics
- ☐ Deepen the knowledge of the robots and their components
- ☐ Understand fundamental concepts in robotics
- ☐ Concepts of motion control of a robotic system
- ☐ Modeling, design, planning, and control of robot systems

- ☐ Intrinsic geometry, kinematics, statics, mechanics, and controls of robotic systems
- ☐ Study the principles of operation of a robotic system
- ☐ Robot perception
- ☐ Motion planning and control
- ☐ SLAM
- ☐ Autonomous navigation
- ☐ Natural language process
- ☐ Analyze the problems and challenges on the fundamentals of the methods in robot systems
- ☐ Probabilistic robotics
- ☐ Multi-robot coordination
- ☐ Human-robot interaction
- ☐ Build a foundation of Robot Operating System

Grading:

Item	Percentage	Individual/Group
Attendance, Participation, and (in class) Pop Quiz	10%	Individual
Assignments (Short questions, reading, and response)	15%	Individual
Lab Assignments	20%	Individual
Mid-term	15%	Individual
Group Project	15%	Group
Final Exam	25%	Individual
Total	100%	

A	92.5 - 100%	A-	89.5 - 92.4%	B+	87 - 89.4%	B	82.5 - 86.9%	B-	80 - 82.4%
C+	77.5 - 79.9%	C	72 - 77.4%	C-	68.5 - 71.9%	D	62.1 - 68.4%	F	< 62%

Reading Assignments: The readings for this course will provide a broad and diverse knowledge in the field of Robotics. Some simple questions

may also be posted on Canvas for each reading, and answers to these questions should be submitted through Canvas by the due date.
Lab Assignments: We will have some lab activities most of each week. Some programming and/or lab activity outcome assignments will be assigned each week, and each lab assignment should be submitted through Canvas or given submission instructions by the due date.
Individual Project: DIY project- Learn concepts and implement them through Project Based Learning, Demo your individual project outcome, conduct a simple remote-control car with localization, and submit a report.
Group Projects: Project activity is one of the major outcomes for the semester. You will perform this project work in teams of 2 ~ 3 consistently throughout the semester. After forming teams early in the class, each team will select a scenario and application for which they will design a robot to address various issues and challenges. Each team will propose those challenges with the state-of-arts, will document their design and prototyping process, and will present their project proposal and final presentation.

Tentative Outline of the Course:

	Topic	
Week 1	Introduction and Course Overview & Fundamental concepts in robotics	
Week 2	Locomotion and manipulation /(Lab) Development Environment Setup	
Week 3	Representations /(Lab) Embedded System Programming - Basic I/O Operation	
Week 4	Kinematics /(Lab) Embedded System Programming - Motor Control	
Week 5	Forces and grasping /(Lab) Embedded System Programming Basic - PID Control	
Week 6	Actuators and Sensors / (Lab) Analog Sensors: Sonar: Noise Filtering	
Week 7	Mapping & Path Planning / (Lab) Sensor Module: IMU	
Week 8	Uncertainty and Error Propagation / (Lab) OLED Module	
Week 9	Localization / (Lab) Odometry: Encoder – Interrupt	
Week 10	Simultaneous Localization and Mapping [SLAM] / (Lab) Protocol - Bluetooth	Individual Project

Week 11	Large Language Model Basic / Ollama	
Week 12	Computer Vision & Feature Extraction / (Lab) Open CV	
Week 13	Artificial Intelligence /(Lab) Yolo	
Week 14	Manipulation and Task execution / (Lab) NLP	
Week 15	Introduction to Robot Operating System (ROS) and AI Robotics	
Week 16	Project Intensive Week	Group Project Demo
Week 17	Final Exam	