Mobile and Autonomous Robotics

UE22CS343BB7

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Mobile and Autonomous Robotics

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Introduction

Session - 1

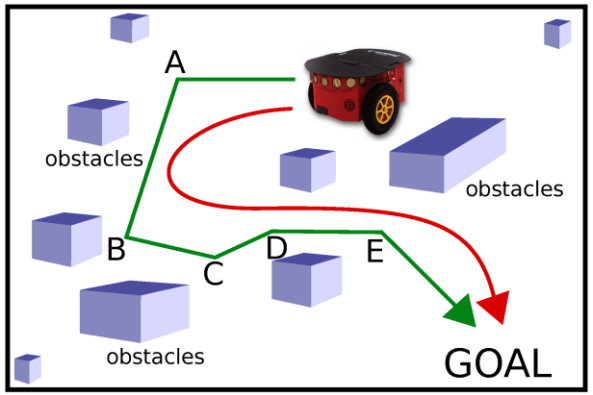
Mobile and Autonomous Robots

Introduction

Robots

- Key questions in Autonomous robotic
  1. What is around me?
  2. Where am I?
  3. Where am I going?
  4. How do I get there?

- Alternatively, these questions correspond to
  1. Sensor Interpretation: what objects are there in the vicinity?
  2. Localization: find your own position on a map (given or built autonomously)
  3. Path planning: decide the actions to perform for reaching a target position
  4. Map building: how to integrate sensor information and your own movement?



Mobile and Autonomous Robots

Course Objectives:

- Understanding the past, present, and future of autonomous mobile robotics. Getting exposed to the current state-of-the-art of scientific literature.
- The course aims to teach the theoretical and practical fundamentals involved in designing and operating autonomous robots.
- The introductory discussions cover subtopics like robot perception, planning, and control.
- Other major topics include understanding robot parts, integrating sensors, analyzing motion kinematics, simulation testing using ROS/ROS2, handling unmodeled environmental and social factors.

Mobile and Autonomous Robots

Course Outcomes:

- Students will gain a comprehensive understanding of autonomous robots and their applications.
- Understand the principles of robot manipulators, end-effectors, and identify the sensors used in robot control.
- Students will understand the ROS architecture and communication protocols and use ROS packages for robot software control.
- They will be able to use path planning and obstacle avoidance algorithms for robot navigation.
- Ultimately, students will be able to apply this knowledge to design and develop their own autonomous robot systems.

Mobile and Autonomous Robots

Course Content:

Unit 1: Introduction to Autonomous Robots: History and current state of autonomous robots, Basic concepts and terminology, Applications of autonomous robots, Robot Hardware and Software, ROS overview: ROS/ROS2 for robotics, ROS architecture and communication protocols, ROS packages for robot hardware control.

Unit 2: Locomotion and Perception: Ground robots (UGVs) 2-DOF and 3-DOF robots, Forward and inverse kinematic, The basics of wheel types and arrangements. Aerial robots (UAVs): 5-DOF and 6-DOF robots, Dynamics of thrusters and propellers, Visual and inertial measurements.

Unit 3: Robot Vision and Localization: Visual perception: Robot vision basics, The basics of scene segmentation and parsing, Introduction and Challenges of Localization, Map-Based Localization, Kalman Filter localization, SLAM.

Unit 4: Navigation: Path planning: the basics of AUV planning. Obstacle avoidance, Sensor fusion, Reinforcement Learning using AI/ML, Applications and Social Implications.

Recommended Materials

- Robot Operating System (ROS): http://wiki.ros.org/ROS/Tutorials
- ROS2 tutorials: https://docs.ros.org/en/foxy/Tutorials.html

Prerequisite:

- Programming language : Python, C++
- Math skills : Linear algebra

Evaluation Pattern

	Marks to be conducted for	Marks to be scaled to
ISA 1 (Units 1 and 2) MCQ	30	15
ISA 2 (Units 3 and 4) MCQ	30	15
Assignments & Mini-Project	20	20
ESA (Questions based on units 1–4)	100	50
Total		**100**

Banana problem (Assignment): 5 marks (conducted for 10 marks)
Orange problem (Mini-Project phase-1): 5 marks (conducted for 10 marks)
Jackfruit problem (Mini-Project phase-2): 10 marks (conducted for 20 marks)

Total: 20 marks

Mobile and Autonomous Robots

Rubrics for Mini-Project

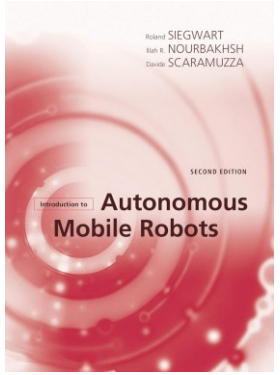
Criteria \ Marks	5-Marks	4-Marks	3-Marks	2-Marks	1/0-Mark
Simulation phase- 1	An error free simulation as mentioned in the abstract. Answering 5 of the questions.	An error free simulation as mentioned in the abstract. Answering 4 or 3 of the questions.	An error free simulation as mentioned in the abstract. Answering 3 or 2 of the questions.	Errors or buggy simulation. Answering 4 or 3 of the questions.	Errors or buggy simulation and Answering 1 or 2 of the questions (1mark). If not answering almost any question (0 marks).
Simulation phase- 2/ Demonstration	An error free simulation and demonstration as mentioned in the abstract with a few last-minute modifications as instructed to check flexibility.	An error free simulation and demonstration as mentioned in the abstract.	An error free simulation and demonstration as mentioned in the abstract with a few errors.	An error free simulation and no demonstration.	No simulation and no demonstration.
Novelty and Viva phase 2	Novelty and 5 questions answered	Novelty and Answered 4 questions.	Novelty and Answered 3 questions.	No novelty and Answered 2 questions	No novelty and Answered 1 question.
Error Handling	Error handling in simulation and demonstration such that functioning is not disrupted majorly with an emergency kill/stop switch.	Error handling in simulation and demonstration with small errors still not handled and with an emergency kill/stop switch.	Error handling in simulation and emergency kill/stop switch but no error handling in demonstration	No error handling but kill/stop switch exists.	No error handling and no kill/stop switch exists.
Robot Interface/ Interaction	Ease of customization. Ease of use. Ability to control sensors, movements and actions. Reliability.	Ease of use. Ability to control sensors, movements and actions. Reliability.	Ease of use. Ability to control movements and actions. Reliability.	Ease of use. Reliability.	No UI.

Mobile and Autonomous Robotics

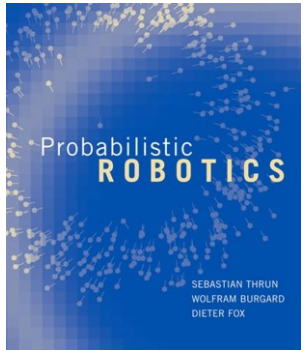
Books:

Prescribed Textbook:

1. Introduction to Autonomous Mobile Robots (Intelligent Robotics and Autonomous Agents series) second edition by Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza

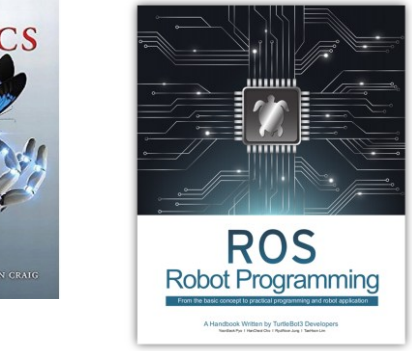


2. Probabilistic Robotics By Sebastian Thrun, Wolfram Burgard and Dieter Fox. (Intelligent Robotics and Autonomous Agents series); 1st Edition



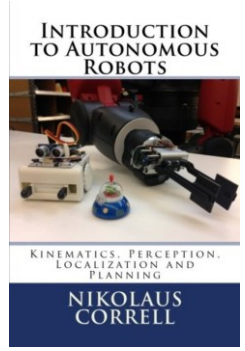
References:

1. Introduction to Autonomous Robots: Nikolaus Correll, Magellan Scientific, 2016.



2. ROS Robot Programming, ROBOTIS Co., Ltd. From the basic concept to practical programming and robot application. YoonSeok Pyo, HanCheol Cho, RyuWoon Jung, and TaeHoon Lim.

3. Introduction to Robotics: Mechanics and Control 4th Edition, John Craig, ISBN-13: 978-0133489798, Pearson; 4th edition



THANK YOU

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