The Hong Kong University of Science and Technology

UG Course Syllabus

Introduction to Mobile Robotics

ELEC 3210

3 Credits

pre-/co-requisites: [(ELEC 2600 OR ELEC 2600H) AND MATH 2111] OR ELEC 3200

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Course Description

The course is to introduce the basic concepts of autonomous navigation used in mobile robotics. Course content includes navigation paradigm, common sensors, Bayes theory, Kalman filter, robot mapping, SLAM, motion planning, and software platforms for robotics research.

Intended Learning Outcomes (ILOs)

By the end of this course, students should be able to:

1. Understand and apply basic concepts of autonomous navigation in mobile robotics, including rigid body kinematics, probabilistic methods and path planning algorithms.
2. Implement and utilize common sensors and algorithms for robot localization and mapping.
3. Develop and integrate software for robotic platforms using Linux/C++ with ROS.
4. Analyze and solve problems using probabilistic methods such as Bayes and Kalman filters.
5. Design and execute path planning algorithms like Dijkstra and A*.

Timetable

Lecture	Date	Contents	Assessment Tasks
L1	03/09	Robotics	Install Ubuntu & Play with ROS
L2	05/09	Pose and Rotation	
L3	10/09	Localization and Kinematics	
L4	12/09	Sensors	
L5	17/09	Iterative Closest Point	P1 - ICP odometry Out

L6	19/09	Map and ROS	
L7	24/09	Bayes Filter	H1 - Bayes Out
L8	26/09	Particle Filter	
	01/10	National Day	
L9	03/10	Kalman Filter and EKF	H1 Due
L10	08/10	EKF SLAM	P1 Due, P2 - EKF SLAM Out
L11	10/10	Place Recognition	
L12	15/10	Pose Graph SLAM	
L13	17/10	Graph SLAM with Landmarks	
L14	22/10	Visual Feature Detection	
L15	24/10	Visual Descriptor and Matching	
L16	29/10	Planning and Graph Construction	P2 Due
L17	31/10	RRT, Dijkstra and A*	P3 - Path planning Out, H2 - Dijkstra vs. BFS Out
L18	05/11	1. Trajectory Planning – Guest Lecturer 2. Summary and Future Robotics	
	07/11		H2 Due
	22/11		P3 Due

Assessments

Assessment Task	Contribution to Overall Course grade (%)	Due date
Homework 1 - Bayes	15%	03/10
Homework 2 - Dijkstra vs. BFS	15%	07/11
Project 1 - ICP Odometry	20%	08/10
Project 2 - EKF SLAM	30%	29/10
Project3 - Path Planning	20%	22/11

Mapping of Course ILOs to Assessment Tasks

Assessed Task	Mapped ILOs	Explanation
Homework 1 - Bayes	ILO1, ILO4	This task assesses students' understanding and application of probabilistic methods (Bayes Rule) for autonomous navigation (ILO 1) and

		their ability to analyze problems using these methods (ILO 4).
Homework 2 - Dijkstra vs. BFS	ILO 1, ILO 5	This task assesses students' ability to understand navigation concepts such as path planning (ILO 1), design the Dijkstra algorithm (ILO 5) and compare it with BFS.
Project 1 - ICP Odometry	ILO 1, ILO 2, ILO 3	This project involves implementing concepts of rigid body kinematics (ILO 1) and using sensors for localization (ILO 2) and to develop software using Linux/C++ and ROS (ILO 3).
Project 2 - EKF SLAM	ILO1, ILO 2, ILO 3, ILO 4	This project tests students' understanding and application of SLAM techniques (ILO 1) to implement localization algorithms (ILO 2), develop software (ILO 3), and apply Kalman filters (ILO 4).
Project3 - Path Planning	ILO1, ILO3, ILO5	This task requires students to design and implement A* path planning algorithm (ILO 1, ILO 5) and integrate software for robotic platforms using Linux/C++ with ROS (ILO 3).

Resubmission Policy

Late submissions are accepted up to 7 days after the due date, with 3% (of the total grade of the item) penalty per day.

Texts and Materials (Non-Compulsory)

- Siegwart, Roland, Illah Reza Nourbakhsh, and Davide Scaramuzza. **Introduction to autonomous mobile robots**. MIT press, 2011.
- Thrun, Sebastian. "**Probabilistic robotics**." Communications of the ACM 45.3 (2002): 52-57.

Academic Integrity

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Additional Resources

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