The Hong Kong University of Science and Technology

UG Course Syllabus

Intelligent Robot and Embodied AI

ELEC 4260

3 Credits

Pre-requisites: ELEC 3130 AND ELEC 3350

Exclusion: ELEC3210 (prior to 2025-26)

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Course Description

AI plays an essential role in robotics to enable them to understand and interact with the surrounding environment. This course gives an introduction to the application of AI in robotics. It focuses on vision-based (and learning-based) techniques to enable robot navigation and object manipulation. This course will cover topics such as map reconstruction, localization, SLAM, path planning, object pose estimation, grasping, manipulation, etc. To help students gain hands-on experiences, this course emphasizes lab tutorials where the students are guided to code on robots for various tasks. Students will be evaluated by course projects and a written exam.

Intended Learning Outcomes (ILOs)

After taking this course, students are expected to understand how modern robots perceive their surrounding environments and plan their actions. In particular, students should be able to:

1. Understand the basic principles of robot navigation, grasping, and manipulation;
2. Learn to formulate and apply machine learning techniques for robotics applications;
3. Learn to implement machine learning algorithms on robot platforms (in both simulator and real robots) ;
4. Learn to test and improve various alogrithms with experiments;
5. Understand and apply vision based robot navigation algorithms;
6. Understand and apply vision based robot grasping and manipulation algorithms;

Assessment and Grading

This course will be assessed using criterion-referencing and grades will not be assigned using a curve. Detailed rubrics for each assignment are provided below, outlining the criteria used for evaluation.

Assessments:

Assessment Task	Contribution to Overall Course grade (%)	Due date
Project 1	20%	TBD
Project 2	20%	TBD
Project 3	20%	TBD
Project 4	20%	TBD
Final Exam	20%	TBD

* Assessment marks for individual assessed tasks will be released within two weeks of the due date.

Mapping of Course ILOs to Assessment Tasks

Assessed Task	Mapped ILOs	Explanation
Odometry Project	ILO1, ILO4	This project tests students' capability to understand the principles of robot navigation (ILO1) and implement and test the odometry algorithms on real robots (ILO4);
Exploration Project	ILO1, ILO4, ILO5	This project tests students' capability to understand the principles of robot navigation (ILO1) and implement and test the odometry algorithms on real robots (ILO4); It will further evaluate students' understanding of vision-based navigation algorithms (ILO5);
Grasp Synthesis Project	ILO1, ILO2, ILO6	This project tests students' capability to understand the principles of robot navigation (ILO1) and formulate machine learning technique for robotics applications (ILO2); It will further test evaluate students' understanding of grasping algorithms (ILO6);
Manipulation Project	ILO1, ILO2, ILO3, ILO6	This project tests students' capability to understand the principles of robot navigation (ILO1) and formulate machine learning technique for robotics applications (ILO2); It will further test evaluate students' capability to develop robot learning algorithms in simulators (ILO3) and understanding of manipulation algorithms (ILO6);
Final Exam	ILO1, ILO2	The final exam mainly focus on the fundamental principles and mathematics part of robot navigation and manipulation tasks.

Grading Rubrics

TBD

Final Grade Descriptors:

Grades	Short Description	Elaboration on subject grading description
A	Excellent Performance	[Example: Demonstrates a comprehensive grasp of subject matter, expertise in problem-solving, and significant creativity in thinking. Exhibits a high capacity for scholarship and collaboration, going beyond core requirements to achieve learning goals.]
B	Good Performance	[Example: Shows good knowledge and understanding of the main subject matter, competence in problem-solving, and the ability to analyze and evaluate issues. Displays high motivation to learn and the ability to work effectively with others.]
C	Satisfactory Performance	[Example: Possesses adequate knowledge of core subject matter, competence in dealing with familiar problems, and some capacity for analysis and critical thinking. Shows persistence and effort to achieve broadly defined learning goals.]
D	Marginal Pass	[Example: Has threshold knowledge of core subject matter, potential to achieve key professional skills, and the ability to make basic judgments. Benefits from the course and has the potential to develop in the discipline.]
F	Fail	[Example: Demonstrates insufficient understanding of the subject matter and lacks the necessary problem-solving skills. Shows limited ability to think critically or analytically and exhibits minimal effort towards achieving learning goals. Does not meet the threshold requirements for professional practice or development in the discipline.]

Course AI Policy

Students can use AI to smooth the language of their written reports. But they are not allowed to use AI to write the programs in the projects.

Communication and Feedback

Assessment marks for individual assessed tasks will be communicated via Canvas within two weeks of submission. Feedback on assignments will include [specific details, e.g., strengths, areas for improvement]. Students who have further questions about the feedback including marks should consult the instructor within five working days after the feedback is received.

Resubmission Policy

Nil

Required Texts and Materials

"Modern Robotics: Mechanics, Planning, and Control," Kevin M. Lynch and Frank C. Park, Cambridge University Press, 2017, ISBN 9781107156302.

“Deep learning”, Ian Goodfellow , Yoshua Bengio, and Aaron Courville. MIT press, 2016, ISBN 9780262035613.

Academic Integrity

Students are expected to adhere to the university’s academic integrity policy. Students are expected to uphold HKUST’s Academic Honor Code and to maintain the highest standards of academic integrity. The University has zero tolerance of academic misconduct. Please refer to Academic Integrity | HKUST – Academic Registry for the University’s definition of plagiarism and ways to avoid cheating and plagiarism.