The Hong Kong University of Science and Technology

UG Course Syllabus

Advanced Construction with AI and Robotics

CIVL4210

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Prerequisite: COMP2011 OR COMP2012 OR COMP2012H

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Course Description

This multi-faceted course encompasses advanced technologies in infrastructure and building construction, maintenance and operations. The course provides deep learning methods in computer vision and robot sensing with hands-on coding training on solving construction management problems with these methods. Combined with tools from AI and robotics, the course equips students with leading-edge knowledge and practices to bring about successful construction reform in the context of the smart city.

The course is a mixture of lectures, tutorials, and student projects. The concept, theory and applications of AI and robotics in construction are delivered through lectures. The tutorials provide hands-on exercises on AI and robotics software development toolkits to learn how to apply these tools with given data. Through mini-projects, students explore the use of the toolkits for practical problem-solving in construction.

Intended Learning Outcomes (ILOs)

Upon completion of the subject, students will be able to:

1. Apply AI tools to building and construction data
2. Evaluate the appropriateness of AI and robotics in building and infrastructure construction, maintenance, and operations.
3. Incorporate AI and robotics for practical construction engineering and management issues

Assessment and Grading

- Assignment (35% = 7 x 5%): these assignments will be based on the coding activities in class for students to investigate the impact of factors or the pros/cons of different algorithms/tools.
- Quiz (20% = 2 x 10%): the two quizzes will measure individual learning outcomes on key concepts and theories in the course and provide feedback to students.
- Mini Project:
    - Mid-term progress report (10%)
    - Final report (20%) and presentation (15%)

- **Summary Table**

Assessment Task	Contribution to Overall Course grade (%)	Due date
Assignment	35%	Every one or two weeks *
Quiz	20%	Tentatively in week 3 and week 5*
Mini project	45%	Tentatively in week 7 and week 13*

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

Mapping of Course ILOs to Assessment Tasks

[add to/delete table as appropriate]

Assessed Task	Mapped ILOs	Explanation
Assignment	ILO1, ILO2, ILO3	This task assesses students' ability to understand and apply AI concepts and tools (ILO 1), evaluate their implications (ILO 2), and critically analyze their role in the industry (ILO 3).
Quiz	ILO1, ILO2	Quizzes are designed to assess students' foundational understanding of AI concepts (ILO 1) and their ability to differentiate AI from construction management (ILO 2), aligning with the lower order thinking skills of remembering and understanding.
Mini project	ILO1, ILO2, ILO3	This task assesses students' ability to understand and apply AI concepts and tools (ILO 1), evaluate their implications (ILO 2), and critically analyze their role in the industry (ILO 3).

Grading Rubrics

Assignment grading rubrics for each assignment

Criteria	Description	Weight
Code Functionality	The code runs without errors and produces the correct output, fulfilling the assignment requirements.	1%
Implementation	The student demonstrates proper implementation of algorithms/tools discussed in class.	1%
Analysis of Factors	The student effectively investigates the impact of relevant factors and provides meaningful insights.	1%
Comparison	The student evaluates the pros/cons of different algorithms/tools and draws well-supported conclusions.	1%

Documentation	The code is well-documented, with clear comments explaining logic and a concise report/summary if required.	1%

Quiz grading rubrics for each quiz

Criteria	**Description**
Multiple choice questions	Full points for correct answers. No partial credit unless explicitly allowed (e.g., if students must select multiple correct answers).
Calculation-based questions	Full points for correct answers with valid reasoning and calculations. Partial credit for minor errors (e.g., incorrect rounding, small arithmetic mistakes) if the approach is correct.

Mini-project grading rubrics for each quiz

Criteria	**40 – 45%**	**30 - 40%**	**20 - 30%**	**10 - 20%**	**0 - 10%**
1. Objectives & Research Agenda	Objectives are clearly stated, well-defined, and highly relevant. The research agenda fully aligns with and adequately addresses the objectives.	Objectives are clear and relevant. The research agenda mostly aligns with and addresses the objectives.	Objectives are somewhat clear, but the research agenda addresses the objectives only partially or with minor inconsistencies.	Objectives are vaguely stated or unclear, and the research agenda addresses the objectives minimally or inconsistently.	Objectives are absent, unclear, or irrelevant. The research agenda does not address the objectives or is entirely misaligned.
2. Research Design & Methodology	The research design is robust, well-structured, and highly appropriate for the objectives. Methodology is thoroughly explained, innovative, and feasible.	The research design is appropriate and well-structured. Methodology is sufficiently explained and mostly feasible.	The research design is somewhat appropriate but lacks detail or has minor flaws. Methodology is explained but lacks clarity or thoroughness.	The research design is weak, underdeveloped, or inappropriate. Methodology is poorly explained or problematic.	The research design is inadequate or absent. Methodology is unclear, non-existent, or entirely inappropriate.
3. Feasibility	The proposed research is highly feasible, with realistic goals, clear steps, and well-considered challenges.	The proposed research is feasible, with mostly realistic goals and some consideration of challenges.	The proposed research is somewhat feasible, but goals or steps may be unclear or poorly planned.	The proposed research is marginally feasible, with unrealistic goals or little consideration of challenges.	The proposed research is infeasible, with unrealistic goals and no consideration of challenges.
4. Originality	The research is highly original or innovative,	The research is original and addresses a	The research shows some originality and	The research shows limited originality and	The research lacks originality and

	addressing a significant gap in the field. If successful, it will bring about substantial advances and meaningful contributions to the field.	relevant gap in the field. If successful, it will bring about notable advances and contributions.	addresses a minor gap in the field. If successful, it will bring about moderate advances or contributions.	addresses an insignificant or unclear gap. Advances or contributions, if any, will be minimal.	does not address any meaningful gap in the field. It is unlikely to bring about any advances or contributions.

Final Grade Descriptors:

[As appropriate to the course and aligned with university standards]

Grades	Short Description	Elaboration on subject grading description
A	Excellent Performance	Demonstrates a comprehensive understanding of AI and robotics concepts and their application in construction. Excels in problem-solving, innovation, and creativity, with outstanding ability to design and implement solutions for complex construction challenges. Participates actively and shows exceptional capacity for collaboration and leadership.
B	Good Performance	Shows strong knowledge of AI and robotics concepts and their application in construction. Demonstrates competence in problem-solving and analysis, with the ability to evaluate and apply tools and algorithms effectively. Displays high motivation and a proactive approach in learning and group work.
C	Satisfactory Performance	Possesses adequate understanding of AI and robotics in construction, with the ability to solve familiar problems and analyze issues at a basic level. Shows persistence and effort to achieve learning objectives but lacks depth or creativity in applying concepts to new challenges.
D	Marginal Pass	Displays threshold knowledge of AI and robotics in construction, with minimal ability to apply concepts effectively or solve problems. Shows limited analytical or critical thinking skills, but demonstrates potential to develop further with focused effort and guidance.
F	Fail	Demonstrates insufficient understanding of AI and robotics concepts, with inability to apply knowledge to construction problems. Lacks problem-solving, critical thinking, and engagement. Fails to meet the necessary requirements for progression or professional development.

Course AI Policy

The use of Generative AI in project is permitted with proper acknowledgement and will NOT be contributed to the students' work.

Communication and Feedback

Assessment marks for individual assessed tasks will be communicated via Canvas within two weeks of submission. Students who have further questions about the feedback including marks should consult the instructor within five working days after the feedback is received.

Late submission Policy

To ensure fairness for students who submit assignments on time, late submissions will not be accepted, and a score of zero will be assigned

Required Texts and Materials

Rafael Sacks, Chuck Eastman, Ghang Lee, Paul Teicholz (2018) BIM Handbook: A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors, and Facility Managers, 3rd Edition. Wiley.

Zacharias Voulgaris and Yunus Emrah Bulut (2018) AI for Data Science: Artificial Intelligence Frameworks and Functionality for Deep Learning, Optimization, and Beyond First Edition, Technics Publications

Bock, T., & Linner, T. (2016). Construction Robots Elementary Technologies and Single-Task Construction Robots. In Construction Robots: Elementary Technologies and Single-Task Construction Robots (p. I). Cambridge: Cambridge University Press.

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.