COURSE PROGRAM

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GENERAL COURSE DESCRIPTION

The course covers advanced technologies leading to redesign and partial or full automation of selected construction processes utilizing industrial robotics. Lectures cover topics such as basic robotic technology (basic principles of robot kinematics and dynamics, industrial manipulators, mobility bases, end effectors, sensors, control systems, and robot task programming), design of automated construction processes, selection of means and methods for automated construction processes, robot ergonomics and safety, calculation of costs and benefits of construction robots in selected applications, engineering and economic feasibility of automation and robotics in the construction industry. Course resources will include repositories of the proceedings of the International Association for Automation and Robotics in Construction <www.iaarc.org> compiled annually since 1984, *Automation in Construction*, an international research journal published since 1992, monograph book titled "*Robotics in Civil Engineering*", and additional materials from a variety of technical resources provided by the instructor.

RECOMMENDED TEXTBOOK

Thomas Bock: Robot-Oriented Design: Design and Management Tools for the Deployment of Automation and Robotics in Construction, Publisher: Cambridge University Press 2015, ISBN: 9781139924146, DOI: https://doi.org/10.1017/CBO9781139924146Links to an external site.

Other materials:

www.iaarc.org

https://www.sciencedirect.com/journal/automation-in-construction
https://link.springer.com/journal/41693
https://www.therobotreport.com/

COURSE OBJECTIVES

The students will learn how to redesign traditional construction processes and tasks to take advantage of the state-of-the-art automation and robotics technology. They will be able to create and recommend construction robot implementation scenarios based on exhaustive engineering and economic analysis of traditional and robotic alternatives.

Class schedule

Class	Topic	HW
1	History of construction automation and robotics.	1
2	Construction project components, physical and cognitive requirements for construction labor, construction task ergonomics.	2
3	Introduction to industrial robot technology, basic types of construction robots.	3
4	Robot components: Manipulators and end effectors	4
5	Robot components: Sensors	5
6	Robot components: Mobility Bases	6
7	Robot components: Control Systems	7
8	Engineering feasibility of construction robot applications.	8
9	Calculation of robot costs and benefits. Economic feasibility of construction robot applications.	9
10	Robot system integration issues in construction: Building Information modeling (BIM), collaborative robotics, additive	10

	manufacturing/3-D printing, automated building construction systems.	
11	Case study in integrated robotic application on construction sites: *Big Canopy* System (Obayashi Corp.)	11
12	Robot safety and ethical issues. Prospects for automated construction sites in Colombia	12

Learning outcomes

Objectives for Class 1

1. Understand course requirements and deliverables
2. Become aware of 3+ decades of construction robot R&D effort worldwide

Objectives for Class 2

1. Determine physical and cognitive components during the execution of construction tasks by human laborers and by robots
2. Understand ergonomic principles of construction tasks performed by humans and by robots

Objectives for Class 3

1. Distinguish between different types of robot designs: remotely controlled, numerically controlled (NC), semi-autonomous and autonomous
2. Make a determination which type of robot is most suitable for a given construction work task

Objectives for Class 4

1. Understand the principles of robot manipulator and end effector design
2. Match manipulator and end effector designs to appropriate construction tasks

Objectives for Class 5

1. Understand the principles of robot sensor design
2. Match sensor designs to appropriate construction tasks

Objectives for Class 6

1. Understand the principles of robot mobility base design
2. Match mobility base designs to appropriate construction tasks

Objectives for Class 7

1. Understand the principles of robot control system design
2. Match robot control system designs to appropriate construction tasks

Objectives for Class 8

1. Determine technical feasibility of robot application to a selected construction task

Objectives for Class 9

By the end of week 9, you should be able to:

1. Determine robot costs and benefits in a given construction task application
2. Determine economic feasibility of construction robots in select applications

Objectives for Class 10

1. Understand the role of integrated robotic systems in high-rise building construction
2. Learn about the achievements of leading Japanese engineering-construction firms in designing and implementing comprehensive robotic solutions
3. Learn about construction robot fleet management solutions developed by the Instructor for Obayashi Corp. (Japan)

Objectives for Class 11

1. Understand robot safety and ethical issues in application to construction tasks
2. Outline the prospects and feasibility of construction robot applications in the U.S. construction industry