

A Quanser Take on Robotics

Robotics has been evolving since the onset of industrialization and is only further fueled by recent advances in all aspects of machine design and intelligence. With an impact on a variety of industries from food and manufacturing, health and rehabilitation, industry automation, self-driving, space exploration, etc., the field is growing its scope towards intelligence, collaboration and digital twins.

Quanser's robotics curriculum offers comprehensive, application-centric learning solutions that span both manipulator and mobile platforms. Built on an open-architecture foundation and designed to be language agnostic, this unified ecosystem provides hands-on experience with industry-standard tools across multiple departments and educational levels. By integrating physical hardware with high-fidelity digital twins—and supplying structured curriculum for each environment—Quanser ensures accessible, flexible instruction for both in-person and remote learners.

The curriculum uses a goal-directed skills progressions and scaffolded labs, exploring fundamental mathematical concepts on kinematics, statics and dynamics hand-in-hand with industrial applications such as workspace identification, lead through, teach pendant, object tracking, self-localization, line-following, etc. By combining solid theoretical foundations with industry/research relevant application, Quanser's curriculum prepares students for both academic research and real-world challenges—from manipulator robotics to mobile robotics, and beyond.

Learning Objectives

- Explore foundational robotic mathematics - position/differential kinematics, statics & dynamics
- Gain operational skills in the practical software implementation of kinematic and dynamic formulations
- Explore essential robotic algorithms related to self-localization, object tracking, path planning & navigation
- Explore industrial applications such as workspace identification, lead through, teach pendant, & task automation
- Critically analyze robot configuration, design and cascade control while developing broad engineering literacy

Textbook Mapping & Reference Material

- Robot Modeling and Control by **M. W. Spong, S. Hutchinson** and **M. Vidyasagar**
- Introduction to Robotics: Mechanics and Control by **J. Craig**
- Introduction to Autonomous Mobile Robots by **R. Siegwart, I. R. Nourbakhsh** and **D. Scaramuzza**

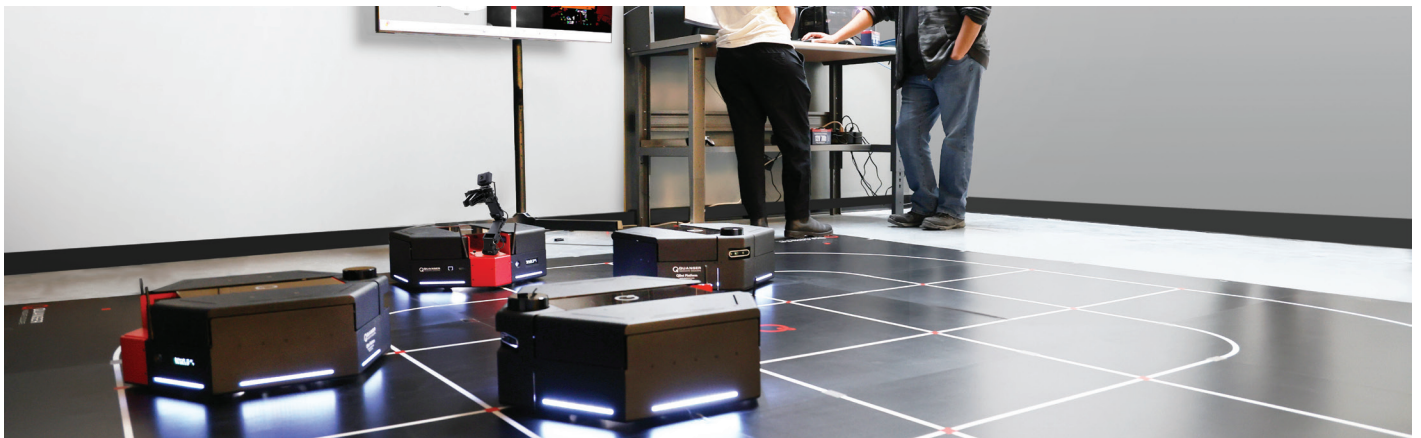
Introduction to Robotics Teaching Lab

This teaching lab empowers educators by providing turn-key experiences consisting of hardware, software, digital twins, full student lab material as well as instructor resources. Equipped with six QArm Mini manipulators, each with four degrees of freedom and an RGB camera, the lab comes with ready-to-deploy curriculum for teaching key manipulation concepts including but not limited to position and velocity kinematics, as well as object recognition and visual servoing.



Mobile Robotics Lab

This teaching and research lab offers a turn-key solution for institutions looking to build or upgrade their mobile robotics capacity. It offers a comprehensive, ready-to-deploy ecosystem equipped with four QBot Platform mobile robots featuring advanced sensors and high-powered NVIDIA GPUs, along with one QArm Mini for hands-on manipulator robotics learning. Complete with ready-to-use courseware and research examples, the lab stands as a full package to cultivate industry-relevant skills and encourage multidisciplinary teamwork.



Intelligent Automation Lab

The Intelligent Automation Lab is a reconfigurable collection of intelligent agents including fixed and mobile robots that can be used to illustrate and address challenges encountered in industrial multi-agent applications such as material handling, multiagent systems, etc. This lab serves as an exciting and motivational context for the application of intelligent systems that can be leveraged for research, teaching, projects, and outreach.



Intelligent Automation Lab

Multidisciplinary Lab for Research, Teaching, and Outreach



University of Manchester
United Kingdom



McMaster University
Canada



University of Waterloo
Canada



Southern Methodist
University
USA



University of Calgary
Canada



Sacred Heart University
USA



Cal Poly Pomona
USA



Simon Fraser University
Canada



California Polytechnic
State University
USA



University of the District
of Columbia
USA



Howard University
USA



St. Mary's University
USA

Quanser users are building a [global community](#) by sharing code, research, and teaching materials to help each other learn and build together.



QArm



QArm Mini



QArm Research



QBot Platform

Table of Contents

Manipulator Robotics

- Forward Kinematics
Workspace Identification
Lead Through
- Inverse Kinematics
Teach Pendant
Trajectory Generation
- Differential Kinematics
Singularity Identification
Singularity Avoidance
Numerical Inverse Kinematics
Statics & payload sensing
- Dynamics
Dynamic modeling and digital twins
Current-based torque sensing
- Perceptions
Morphological Object Detection
Intelligent Object Detection
- Visual Manipulation
Joint space visual servoing
Task space visual servoing
Cobotics

Mobile Robotics

- Forward Differential Kinematics
Wheel speed motor control
Body speed estimation
- Inverse Differential Kinematics
Body speed actuation
Task space speed control
- Local navigation
Blob detection
Line following
Obstacle Detection
- Self-localization
Lidar Scan Matching
Sensor fusion
- Navigation & Control
Position Control
Robot Navigation
Simultaneous Mapping & Localization
- Warehouse Automation
Task Queue Execution
Task Queue Generation
Multirobot collaboration