CMSC 756/ENEE 769M: Robotics

Fall 2021

IRB 2107

Tu, Th: 2:00pm - 3:15pm

Instructor: Dinesh Manocha

Prerequisites:

Data Structures (CMSC 420 or equivalent), Programming (CMSC 106 or equivalent), Numeric Analysis (CMSC466 or equivalent), Linear Algebra (Math 240 or equivalent)

Course Objective:

To learn about the design, programming, and control of robotic systems.

Approach:

Class lectures, mathematical homeworks, programming assignments, class project.

Syllabus:

Topics include kinematics, inverse kinematics, dynamics, actuation, sensing, manipulation, control, motion planning, multi-agent navigation. Applications including industrial, mobile, and autonomous driving

Course Background:

Robotics is the study of robot design, programming, and control. Typically a robot is referred to as an agent that can be programmed to perform a variety of tasks -- both with and without human intervention. A robot is often manifested and realized by mechanical and electrical components to carry out its actions in the physical world. Robots frequently receive input from noisy sensors, consider geometric and mechanical constraints, and operate in the physical world through imprecise actuators. The design and analysis of robot algorithms and computational elements, therefore, raises a unique combination of questions in computational and differential geometry, algorithm design, control theory, mechanics, computer science, and system engineering.

In this course, we will give an overview on fundamental components of robotic systems, including the sensing and actuation, control and modeling of motion and perception, dynamics and kinematics, motion planning and manipulation of robots. Students will learn about implementation of basic simulation programs that produce interesting results and verify its correctness. The goal of this class is to get students an appreciation of computational methods and engineering issues for modeling robots. We will discuss various considerations and tradeoffs used in designing various methodologies (e.g. time, space, robustness, and generality). This will include data structures, algorithms, computational methods, simulation techniques, runtime complexity, system implementation and integration, in the context of multi-disciplinary design.

Course Outline:

Numbers in parentheses indicate approximate number of weeks

- Definition and history of robotics (1)
- Kinematics (1)
- Inverse kinematics (1)
- Dynamics (1)
- Actuation/Control (1)
- Sensing (1)
- Manipulation (1)
- Collision Detection (1)
- Motion Planning (2)
- Multi-agent/Multi-robot systems (2)
- Applications (2)