ME599 E: Robotics, Vision, and Mechatronics

Syllabus

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Associate Professor

University of Washington

Topic

This course is

- an introduction to robotics, visual sensing, and controls
  - robotics: the fundamentals of robotic manipulation
  - sensing: computer vision
  - controls: focused discussions on vision-based planning and controls in a 3-dimensional space
- a hands-on demonstration of tools at the intersection of robotics and mechatronics for manufacturing
- aimed at providing key insights into how complex problems can be decomposed and solved using powerful numerical tools and effective software

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Topics

Foundations

the concepts of pose and coordinate frames

Position and orientation

how pose can be represented in a computer

Time and motion

the relationship between velocity and the derivative of pose

(Mobile robot intro)

Topics

Robot manipulator

Kinematics

relates the angles of the robot's joints to the 3-dimensional pose of the robot's tool

Velocity

the relationships between the rates of change of joint angles and tool pose

Dynamics and control

the design of joint control systems, the dynamic equations of motion for a serial-link manipulator, and the relationship between joint forces and joint motion.

Topics

Computer vision

Light and color

the fundamentals of light, illumination and color

Image formation

the geometric model of perspective image creation using lenses and discusses topics such as camera calibration and pose estimation

Image processing

a domain of 2-dimensional signal processing that transforms one image into another image

Image feature extraction

describe how numerical features are extracted from images

Topics

Robotics, vision, and control

Vision-based control

Advanced visual servoing

Advanced mobile robots

Prerequisites

- Undergraduate controls (if not, take ME 471 or ME 547).
- Familiarity with using and programming in MATLAB.
- Engineering mathematics: ME 564 Mechanical Engineering Analysis or EE 510 (can be taken concurrently).
  - linear algebra (matrices, vectors, eigenvalues, etc), basic set theory, and probability
  - dynamics, differential equations, equations of motion

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Your teaching team

- Prof. Xu Chen, chx AT uw.edu, MEB 325, Phone: (206)-543-5705
- Teaching Support: Dan Wang, Hui Xiao

Topic

Content delivery

- Website: UW Canvas
- Lectures: Zoom meetings at scheduled class time (Tu Thur 10-11:20am).
- Textbook (required): Robotics, Vision, and Controls - Fundamental Algorithms in MATLAB, by Peter Corke, 2nd Edition
- From time to time, student presentations to foster a mindset of content planning and technical communication

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Grading

- Participation [10%]
- Homework / virtual labs [50%]
- Class presentation and peer review [10%]
- Project [30%]

More on homework

- Homework will be announced on the class canvas website. Submit a typed or clearly scanned copy of your homework directly on Canvas.
- No late homework will be accepted. Late homeworks are not fair to the TAs and to other students. Submit what you have on time. You may submit revised/new sections of the problem sets late, but only before the release of solutions and with a 50% reduction in scores. The mechanism allows you to catch up if you fall behind. But the 50% penalty is fixed.

Topic

Matlab and related toolboxes

- The Robotics Toolbox (RTB): provides a diverse range of functions for simulating mobile and arm-type robots.
- The Machine Vision Toolbox (MVTB): provides a rich collection of functions for camera modeling, image processing, image feature extraction, multi-view geometry and vision-based control.
- Download and install from https://petercorke.com/toolboxes/robotics-toolbox/

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Topic

HW 1

literature review of applications of vision-based robotics