Introduction to Modern Controls

Introduction

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- The power of *feedback controls*: it allows us to make a precision device out of a crude one that works well even in changing environments.
- We also use *prediction and feedforward controls*: as kids, we had learned to wear T-shirts in summer, long sleeves and coats in winter. With such predictive and feedforward controls, the burden of feedback control is greatly lifted.

Analysis and control of linear dynamic systems

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- Feedback: the use of information of the past or the present to influence behaviors of a system

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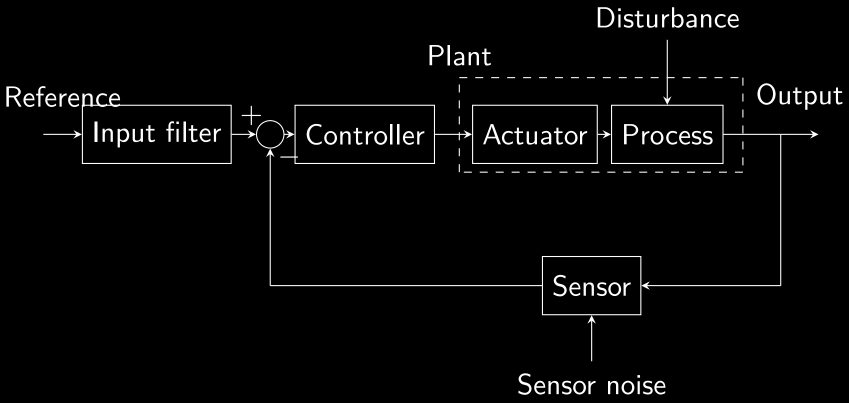
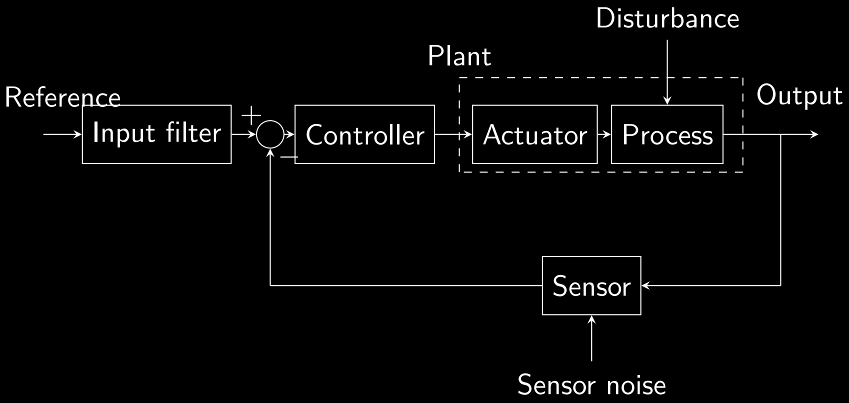
- Performance: cannot be done "as well" by humans
- Cost: Humans are more expensive and can get bored
- Robustness: can deliver the requisite performance even if process behaves slightly differently

Terminologies



- Process: whose output(s) is/are to be controlled

Terminologies



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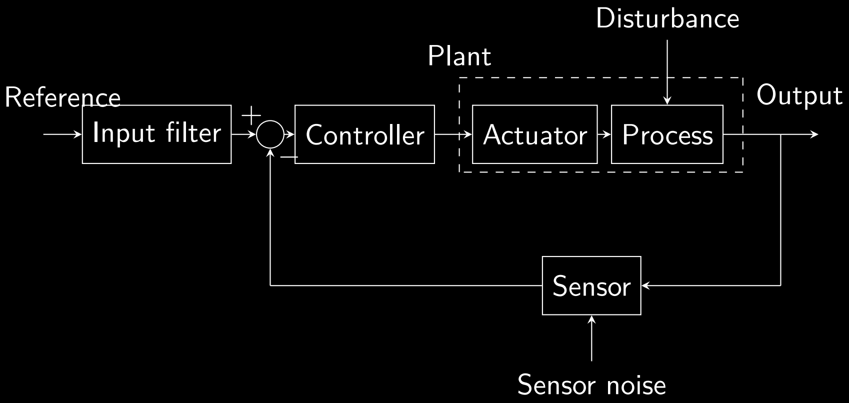

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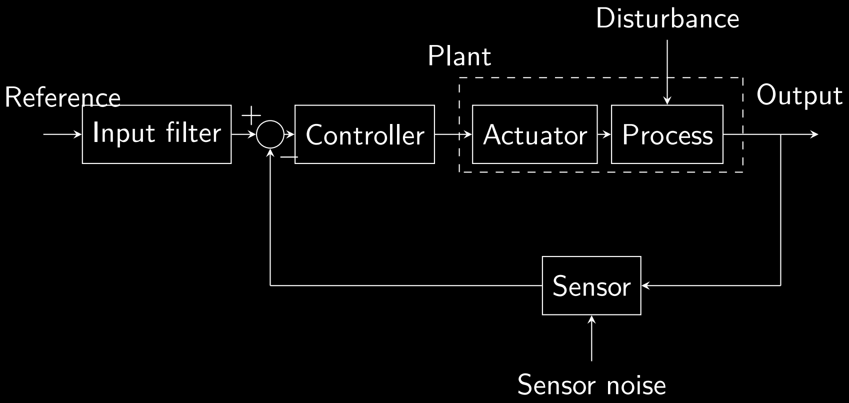

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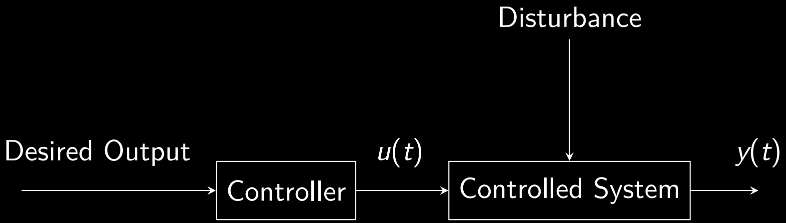
- Plant: process + actuator
- Block diagram: visualizes system structure and the flow information in control systems

Open-loop control v.s. closed-loop control



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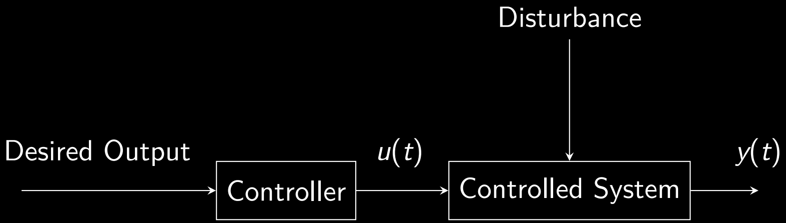

- the output of the plant does not influence the input to the controller
- input and output as *signals*: functions of time, e.g., speed of a car, temperature in a room, voltage applied to a motor, price of a stock, electrical-cardiograph, all as functions of time.

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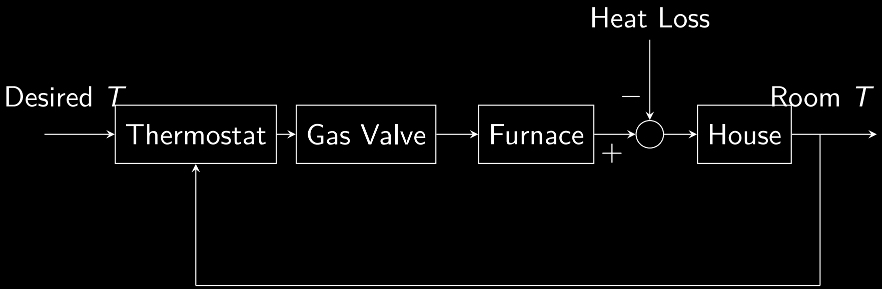

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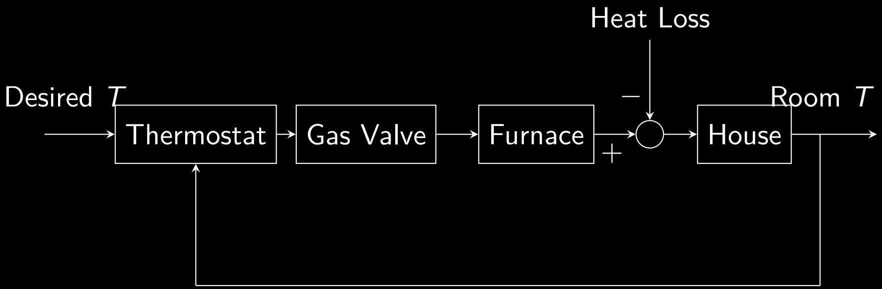

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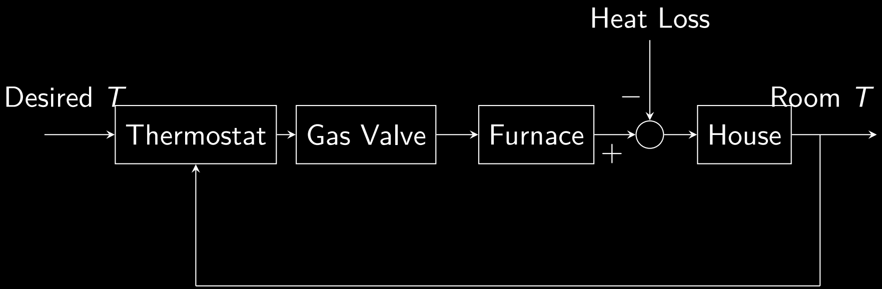
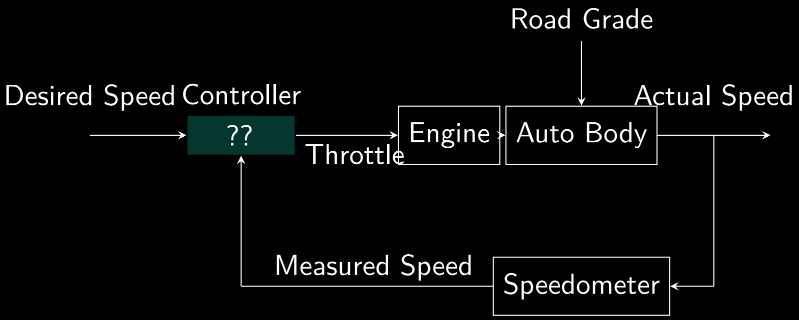
- there is always feedback in a closed-loop system

Closed-loop control: regulation example



Regulation control example: automobile cruise control



- What is the control objective?
- What are the process, process output, actuator, sensor, reference, and disturbance?

Control objectives

- Better stability

There are some aspects of control objectives that are universal. For example, we would always want our control system to result in closed-loop dynamics that are insensitive to disturbances. This is the disturbance rejection problem. Also, as pointed out previously, we would want the controller to be robust to plant modeling errors.

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- Better stability
- Improved response characteristics
- *Regulation* of output in the presence of disturbances and noises
- Robustness to plant uncertainties
- *Tracking* time varying desired output

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Means to achieve the control objectives

- Model the controlled plant

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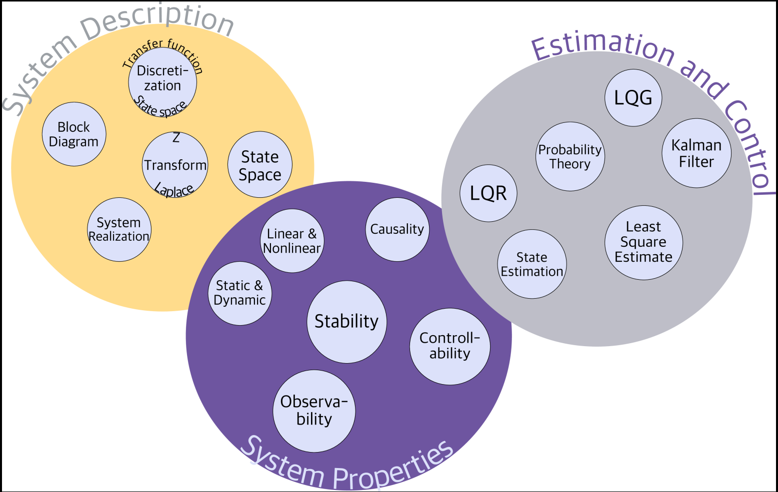
- Analyze the characteristics of the plant
- Design control algorithms (controllers)
- Analyze performance and robustness of the control system
- Implement the controller

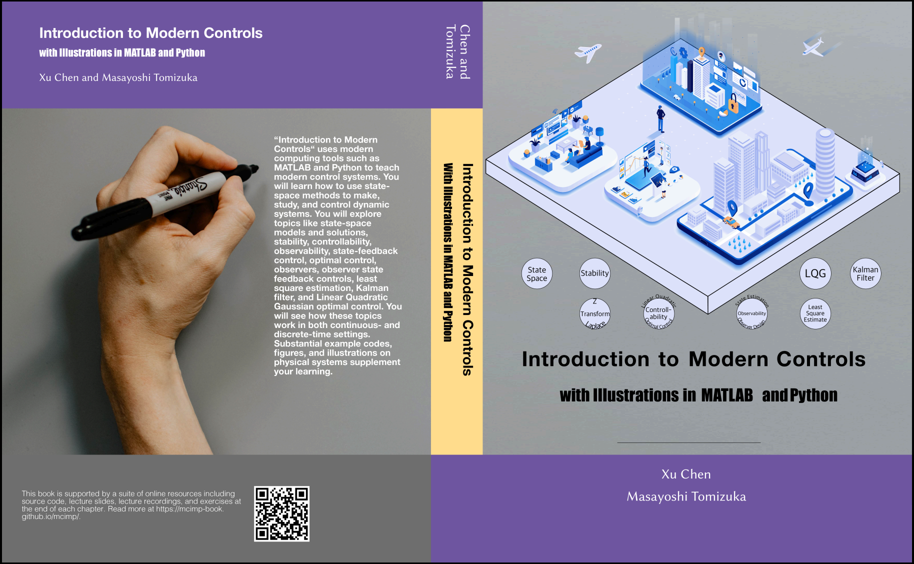
About this course

- a first-year graduate course on modern control systems



- a prerequisite to most advanced control courses

Textbook


Introduction to Modern Controls
with Illustrations in MATLAB and Python
Xu Chen and Masayoshi Tomizuka
Chen and Tomizuka
“Introduction to Modern Controls“ uses modern computing tools such as MATLAB and Python to teach modern control systems. You will learn how to use state-space methods to make, study, and control dynamic systems. You will explore topics like state-space models and solutions, stability, controllability, observability, state-feedback control, optimal control, observers, observer state feedback controls, least square estimation, Kalman filter, and Linear Quadratic Gaussian optimal control. You will see how these topics work in both continuous- and discrete-time settings. Substantial example codes, figures, and illustrations on physical systems supplement your learning.
Introduction to Modern Controls
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This book is supported by a suite of online resources including source code, lecture slides, lecture recordings, and exercises at the end of each chapter. Read more at https://mcimp-book.github.io/mcimp/.
State Space
Stability
Z Transform
Laplace
Controll-ability
Observability
LQG
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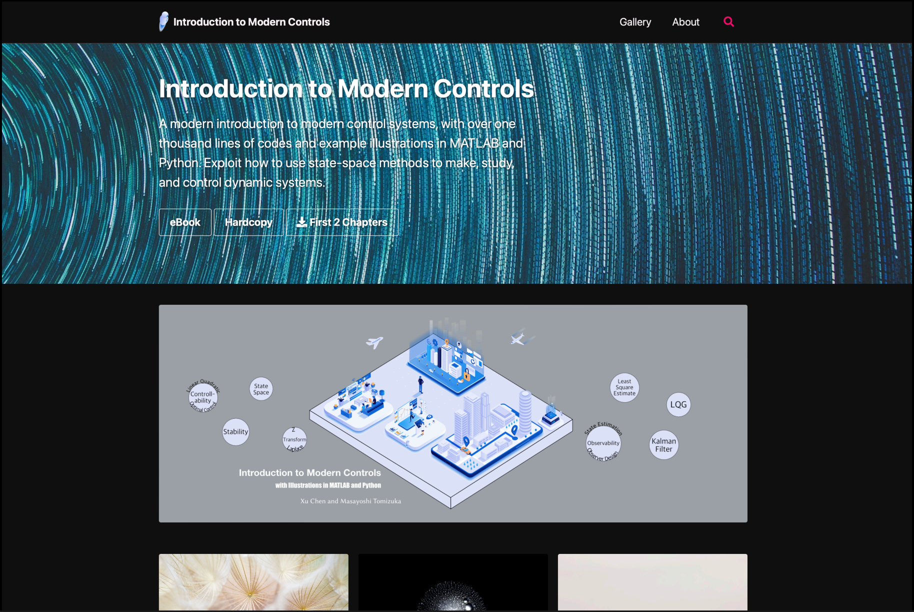
Textbook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A modern introduction to modern control systems, with over one thousand lines of codes and example illustrations in MATLAB and Python. Exploit how to use state-space methods to make, study, and control dynamic systems.
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Linear Quadratic
Controll-ability
Optimal Control
State Space
Stability
Z
Transform
Laplace
Least Square Estimate
LQG
State Estimation
Observability
Observer Design
Kalman Filter
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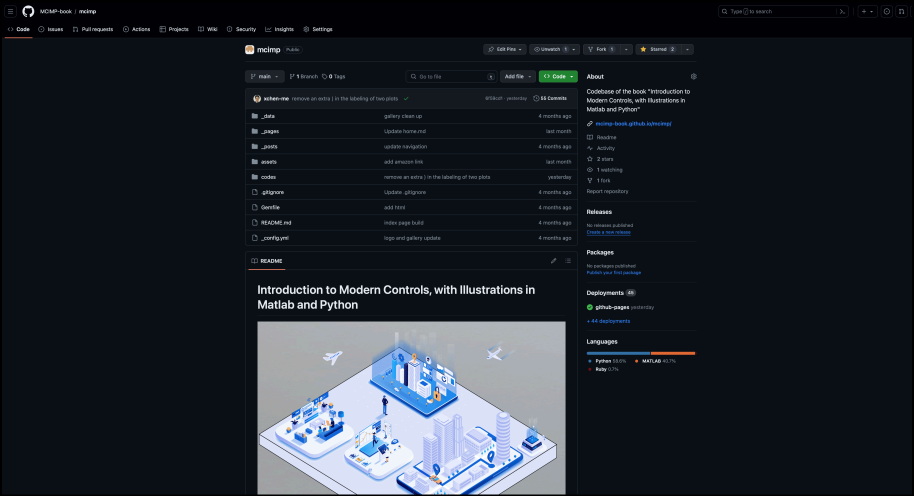
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Actions
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Security
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Type / to search
mcimp
Public
Edit Pins
Unwatch 1
Fork 1
Starred 2
main
1 Branch
0 Tags
Go to file
Add file
Code
xchen-me remove an extra) in the labeling of two plots
6f59cd1 · yesterday
55 Commits
_data gallery clean up 4 months ago
_pages Update home.md last month
_posts update navigation 4 months ago
assets add amazon link last month
codes remove an extra) in the labeling of two plots yesterday
.gitignore Update .gitignore 4 months ago
Gemfile add html 4 months ago
README.md index page build 4 months ago
_config.yml logo and gallery update 4 months ago
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Readme
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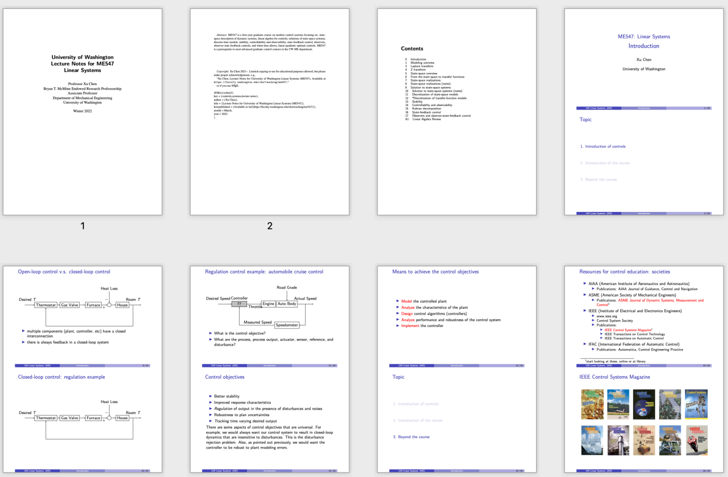
2 stars
1 watching
1 fork
Report repository
Releases
No releases published
Create a new release
Packages
No packages published
Publish your first package
Deployments 45
github-pages yesterday
+ 44 deployments
Languages
Python 58.6%
MATLAB 40.7%
Ruby 0.7%

Written materials

- Open-source Course Notes



Resources for control education: societies

- AIAA (American Institute of Aeronautics and Astronautics)
  - Publications: AIAA Journal of Guidance, Control and Navigation
- ASME (American Society of Mechanical Engineers)
  - Publications: ASME Journal of Dynamic Systems, Measurement and Control[1]
- IEEE (Institute of Electrical and Electronics Engineers)
  - www.ieee.org
  - Control System Society
  - Publications:
    - IEEE Control Systems Magazine[1]
    - IEEE Transactions on Control Technology
    - IEEE Transactions on Automatic Control
- IFAC (International Federation of Automatic Control)
  - Publications: Automatica, Control Engineering Practice

[1] start looking at these, online or at library

IEEE Control Systems Magazine