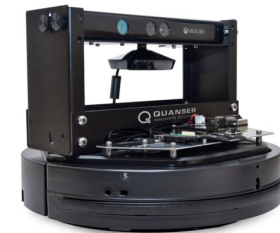
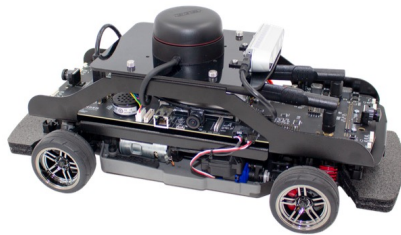
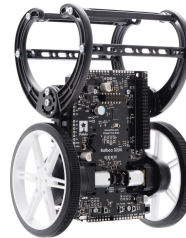


Control of mobile robots



Hugues GARNIER

hugues.garnier@univ-lorraine.fr

September 2026

Volumes horaires

- **Contrôle de robots mobiles**
 - 1 séance de cours *de 2h* 2h
 - 2 séances de TP *de 4h* 8h
 - Mini-projets (*en binôme*) 24h

- Intervenants en cours/TP
 - Hugues Garnier
- Intervenants en mini-projets
 - Hugues Garnier
 - Théo Rutschke

Contrôle des connaissances

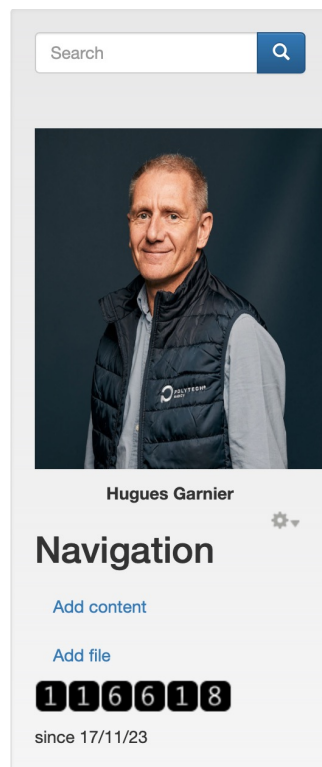
- 1 rapport de mini-projet
 - A faire en binôme
- 1 présentation orale de mini-projet
 - A faire en binôme
- Calcul de la note finale

$$\text{Note EC} = 0,25 \text{ rapport} + 0,75 \text{ Oral}$$



Website for the course : *Labs & mini-projects*

- w3.cran.univ-lorraine.fr/hugues.garnier/?q=content/teaching



Teaching

Basic page *Teaching* has been updated.

[View](#) [Edit](#)

Teaching activities

Since 2018, I have been teaching the following courses at [Polytech Nancy](#):

Robotics S5 (3A IA2R FISE)

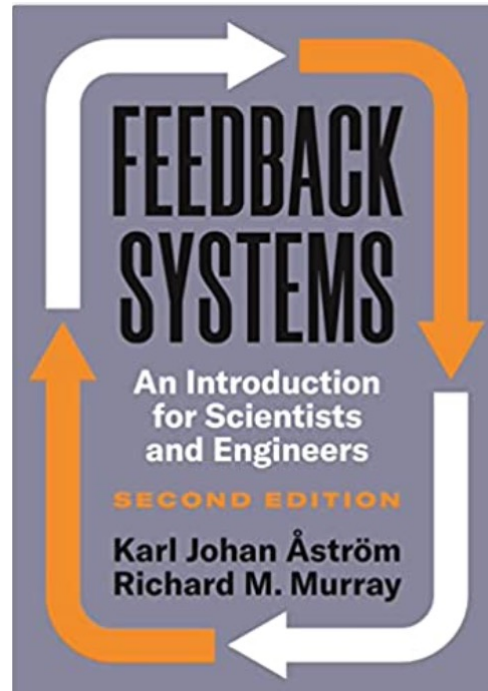
- [Lab 1 - Sensors and actuators of the QUBE servo 2](#)
 - [QUBE-Servo 2 pdf guides](#)

Control of Mobile Robots S9 (5A IA2R Parcours SIA)

- [Introduction to the course](#)
- [Tutorials](#) - [Correction_tutorials](#)
- Labs
 - Lab 1 - PID control of the QUBE-Servo 2
 - [QUBE-Servo 2 pdf guides](#)
 - [Files for the PID control](#)
 - Lab 2 - State-feedback control of QUBE rotary inverted pendulum
 - [Files for the State-feedback control](#)
 - Mini-projects
 1. Control design for the self-driving Qcar
 2. Control design for the Qbot
 3. Control design for the self-balancing Balboa robot
 4. MPC control design for the rotary inverted pendulum
 5. Control design for the Tello mini-drone
 6. Control design for the AERO system
- Feedback about the course from the students
 - [Feedback](#) from students 2024-2025

Recommended book in Control Feedback Systems

An Introduction for Scientists and Engineers, *K.J. Åström & R. Murray 2021*

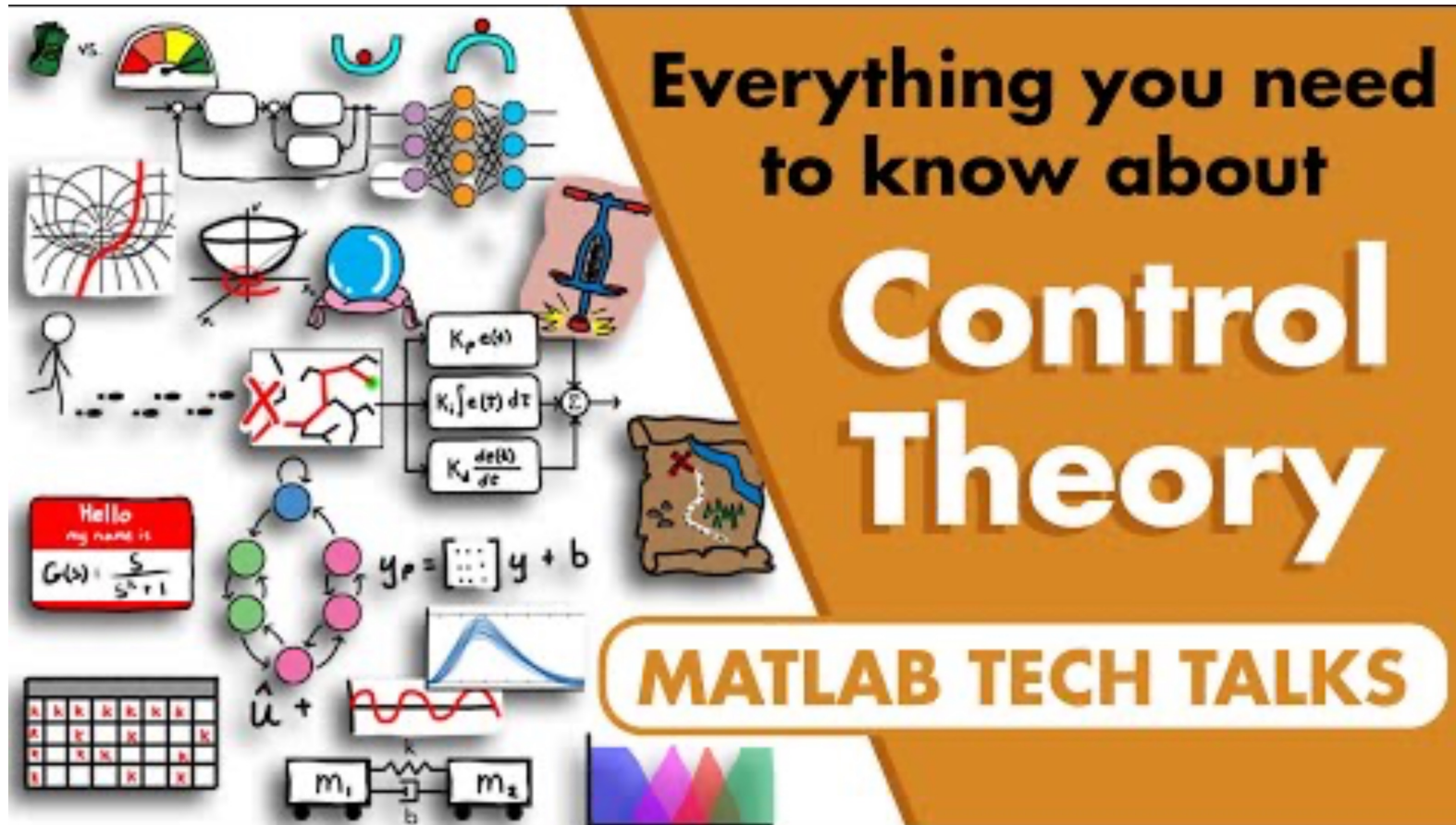


pdf version of the book available

http://www.cds.caltech.edu/~murray/books/AM08/pdf/fbs-public_24Jul2020.pdf

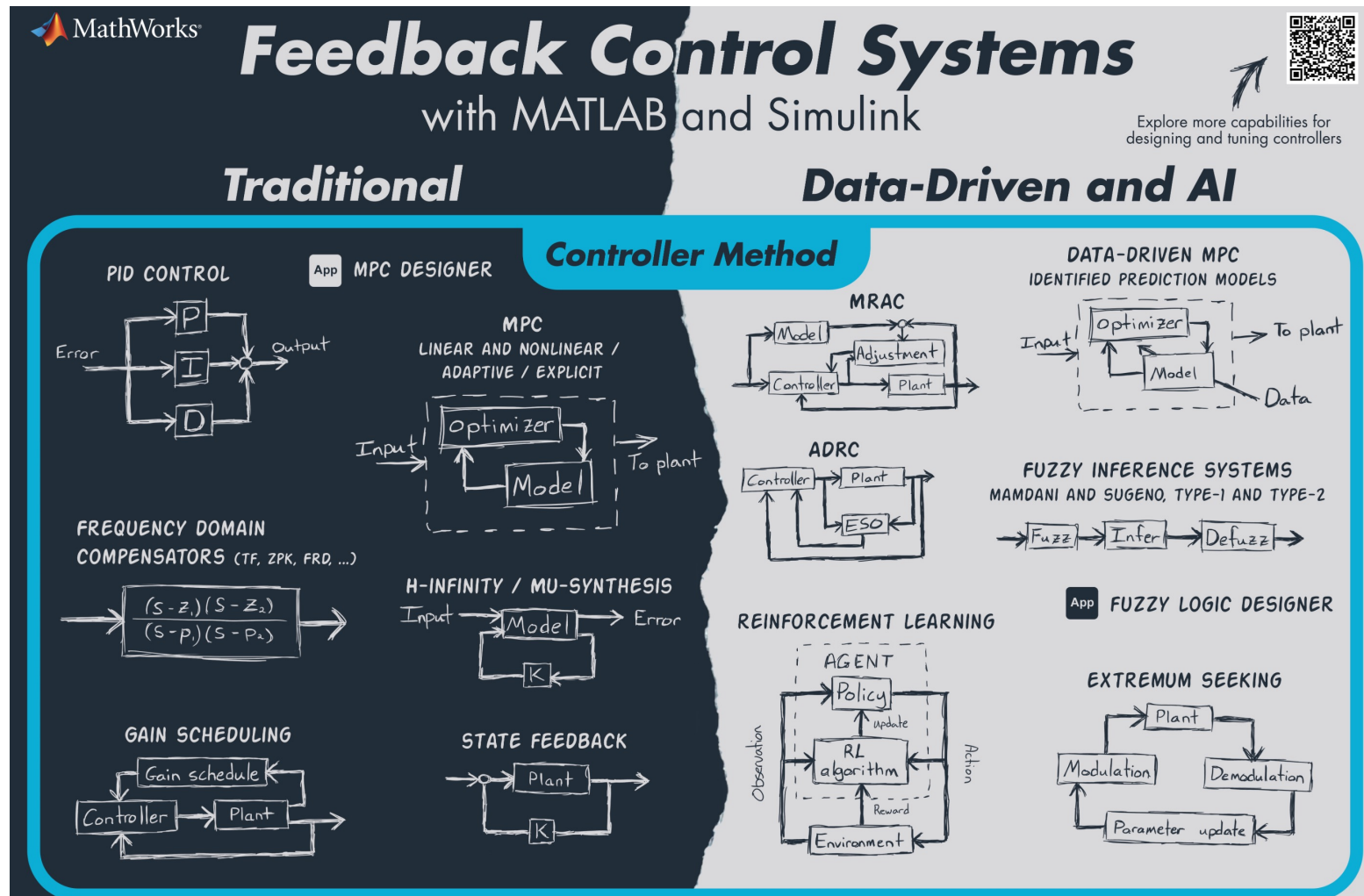
Other ressource recommended in Control Matlab Tech Talks with *Brian Douglas*

Everything you need to know about control theory



www.youtube.com/watch?v=IBC1nEq0_nk

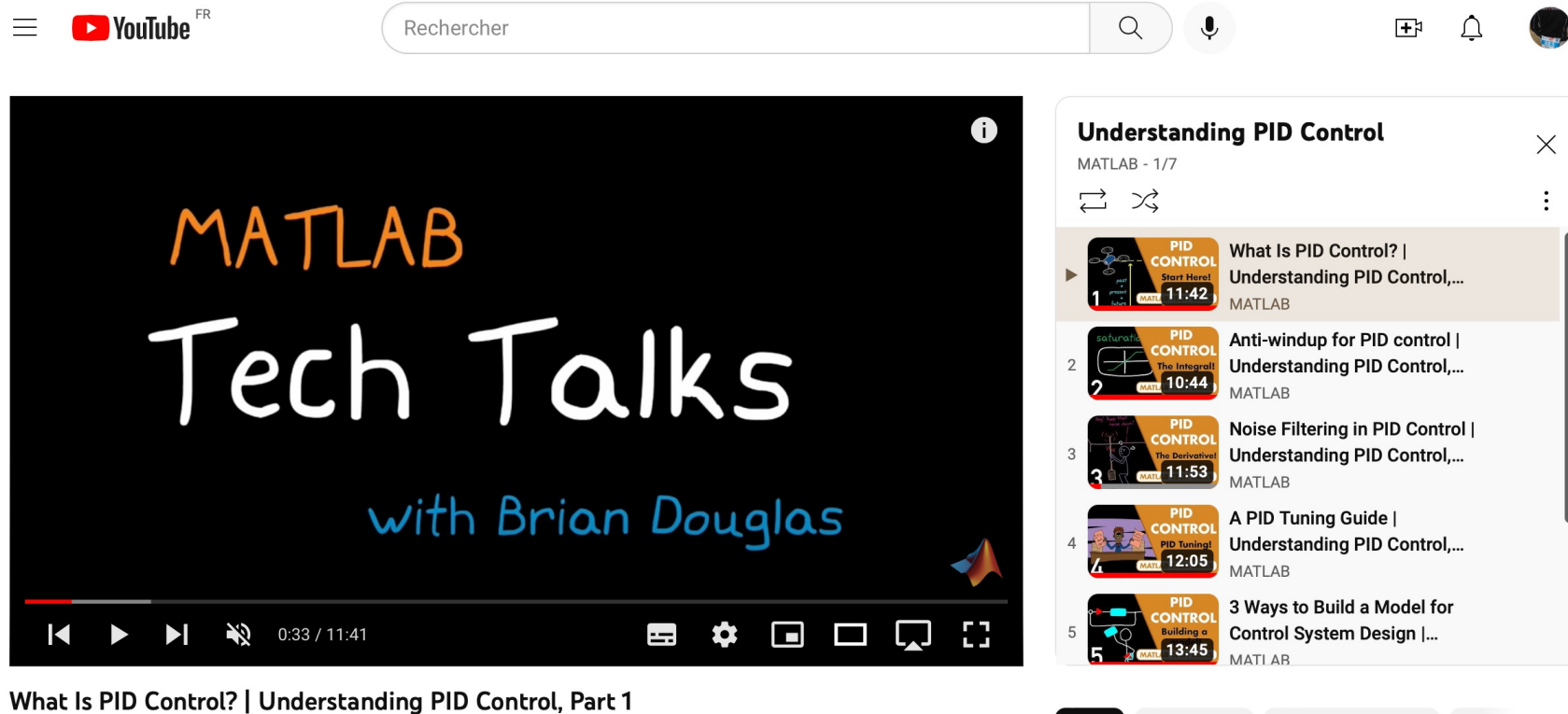
Traditional model-driven methods *versus* data-driven/AI control methods



Other ressource recommended in Control

Matlab Tech Talks with *Brian Douglas*

Understanding PID control



The screenshot shows a YouTube interface. The main video player displays the title 'MATLAB Tech Talks with Brian Douglas' in a stylized font. Below the video, the title 'What Is PID Control? | Understanding PID Control, Part 1' is visible. To the right, a playlist titled 'Understanding PID Control' is shown, containing five videos:

- 1. What Is PID Control? | Understanding PID Control, Part 1 (11:42)
- 2. Anti-windup for PID control | Understanding PID Control, Part 2 (10:44)
- 3. Noise Filtering in PID Control | Understanding PID Control, Part 3 (11:53)
- 4. A PID Tuning Guide | Understanding PID Control, Part 4 (12:05)
- 5. 3 Ways to Build a Model for Control System Design | Understanding PID Control, Part 5 (13:45)

Other ressource recommended in Control

Matlab Tech Talks with *Brian Douglas*

State-space model and control

The screenshot shows a YouTube interface. The main video player displays the title "MATLAB Tech Talks with Brian Douglas" in a stylized font. Below the title, it says "Introduction to State-Space Equations | State Space, Part 1". The video progress bar shows 0:35 / 14:11. To the right of the video player, there is a playlist titled "State Space" with 4 videos. The first video is "Introduction to State-Space Equations | State Space, Part 1" (14:12). The second video is "What is Pole Placement (Full State Feedback) | State Space,..." (14:55). The third video is "A Conceptual Approach to Controllability and Observability..." (13:30). The fourth video is "What Is Linear Quadratic Regulator (LQR) Optimal Control..." (17:24). At the bottom of the playlist, there are tabs for "Tout", "De la série", "Équations", and "Leçons".

Other ressource recommended in Control

Control Bootcamp by *Steve Brunton*

- <https://www.youtube.com/playlist?list=PLMrJAKhleNNR20Mz-VpzgfQs5zrYi085m>



Control Bootcamp

Steve Brunton
39 vidéos 1 305 289 vues Dernière modification le 8 oct....

⋮ ➦ ⋮

Tout lire **Aléatoire**

This course provides a rapid overview of optimal control (controllability, observability, LQR, Kalman filter, etc.). It is not meant to be an exhaustive treatment, but instead provides a high-level overview of some of the main approaches, applied to simple examples in Matlab.

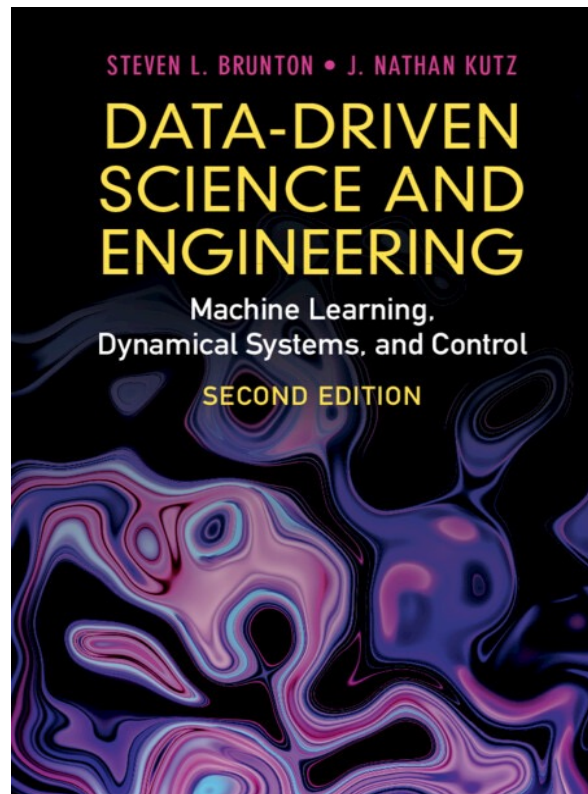
These lectures follow Chapter 8 from: "Data-Driven Science and Engineering: Machine Learning, Dynamical Systems, and Control" by Brunton and Kutz

- 1 **Control Bootcamp: Overview**
Steve Brunton • 325 k vues • il y a 5 ans
19:32
- 2 **Linear Systems [Control Bootcamp]**
Steve Brunton • 125 k vues • il y a 5 ans
24:47
- 3 **Stability and Eigenvalues [Control Bootcamp]**
Steve Brunton • 115 k vues • il y a 5 ans
19:30
- 4 **Linearizing Around a Fixed Point [Control Bootcamp]**
Steve Brunton • 107 k vues • il y a 5 ans
30:46
- 5 **Controllability [Control Bootcamp]**
Steve Brunton • 115 k vues • il y a 5 ans
32:30
- 6 **Controllability, Reachability, and Eigenvalue Placement [Control Bootcamp]**
Steve Brunton • 57 k vues • il y a 5 ans
10:49

Other book recommended

Data-Driven Science and Engineering

Machine Learning, Dynamical Systems, and Control *S. Brunton & N. Kutz 2022*



Part I. Dimensionality Reduction and Transforms:

1. Singular Value Decomposition
2. Fourier and Wavelet Transforms
3. Sparsity and Compressed Sensing

Part II. Machine Learning and Data Analysis:

4. Regression and Model Selection
5. Clustering and Classification
- 6. Neural Networks and Deep Learning*

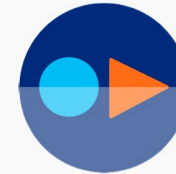
Part III. Dynamics and Control

- 7. Data-Driven Dynamical Systems*
- 8. Linear Control Theory*
- 9. Balanced Models for Control*

Part IV. Advanced Data-Driven Modeling and Control:

- 10. Data-Driven Control*
- 11. Reinforcement Learning*
12. Reduced Order Models (ROMs)
13. Interpolation for Parametric ROMs
14. Physics-Informed Machine Learning

Other ressource recommended in Control: **Textbook available from *Quanser***



Experience Controls by Quanser

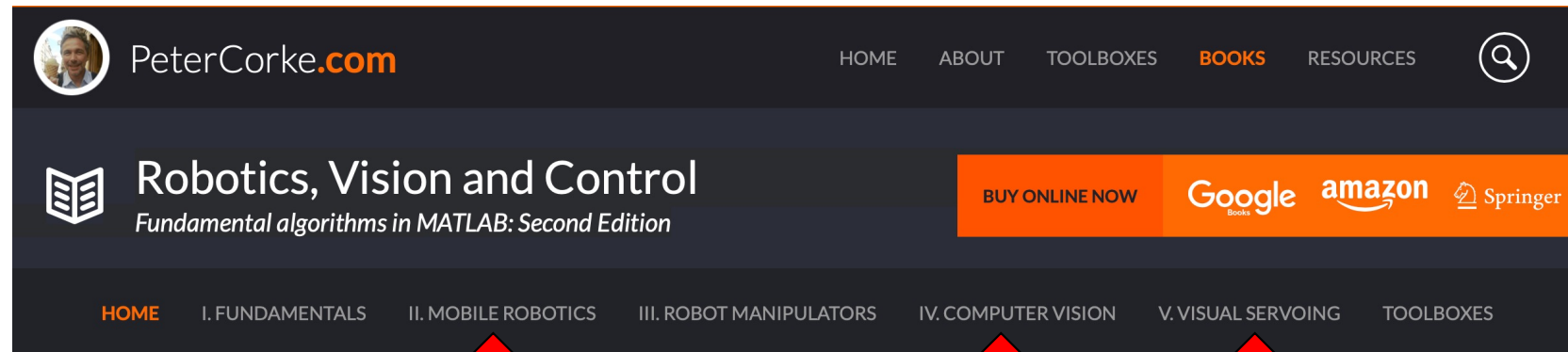
Experience Controls is a free mobile textbook designed to give you real design intuition and relevant skills in a hands-on way in the control systems engineering space.

The textbook app includes:

- 50+ lesson modules covering introductory to advanced concepts
- Interactive simulations of industrial-level controls problems
- Mini-lecture podcasts that summarize key takeaways for each chapter, available in-app or in your preferred podcast player
- End-of-chapter review questions to check your understanding



Recommended book in mobile robots



Home

This book makes the fundamental algorithms of robotics, vision and control accessible to all. It weaves together theory, algorithms and examples in a narrative that covers robotics and computer vision separately and together. The author shows how complex problems can be decomposed and solved using just a few simple lines of code, supported by two MATLAB® Toolboxes. The topics covered are guided by real problems observed by the author over many years as a practitioner of both robotics and computer vision.

It is written in a light but informative style, it is easy to read and absorb, and includes over 1000 MATLAB® and Simulink® examples and figures. The book is a walk through the fundamentals of mobile robots, navigation, localization, arm-robot kinematics, dynamics and joint level control, then camera models, image processing, feature extraction and model-based navigation and control, interactive learning, and more.

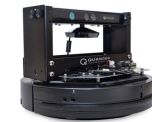


Proposed mini-projects

1. Model-based trajectory tracking control for the autonomous QCar



2. Model-based trajectory tracking control for the differential-drive mobile Qbot



3. Model-based stabilization and control for the self-balancing Balboa robot



4. Model Predictive Control (MPC) for the rotary inverted pendulum



5. Model-based flight control design for the Tello mini-drone



6. Model-based flight control for the Quanser AERO Helicopter

