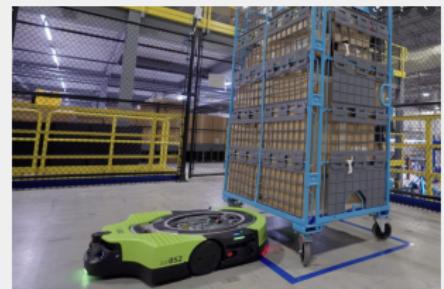


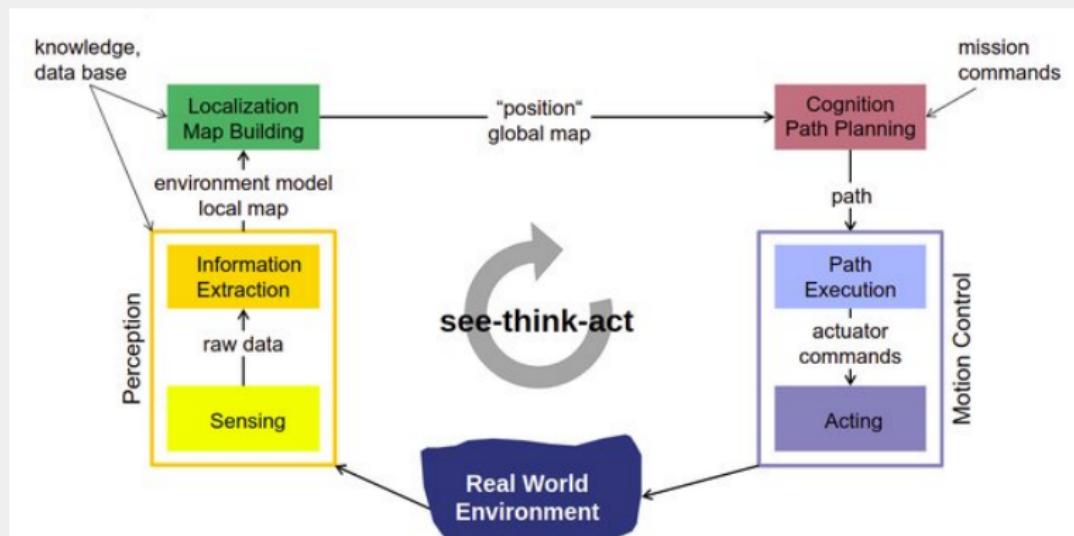
AUTONOMOUS MOBILE ROBOTS

GEESARA KULATHUNGA

JANUARY 24, 2023

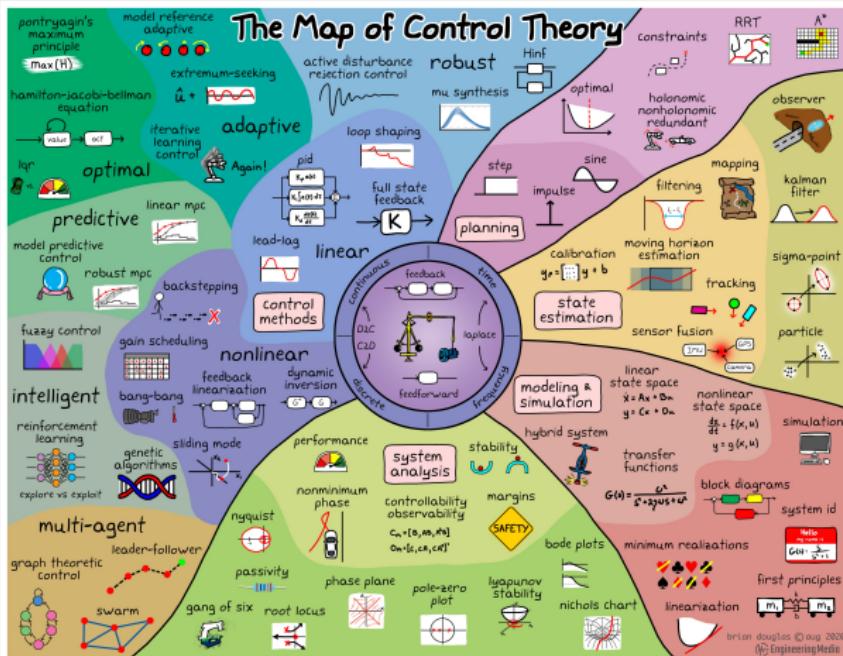


INTRODUCTION



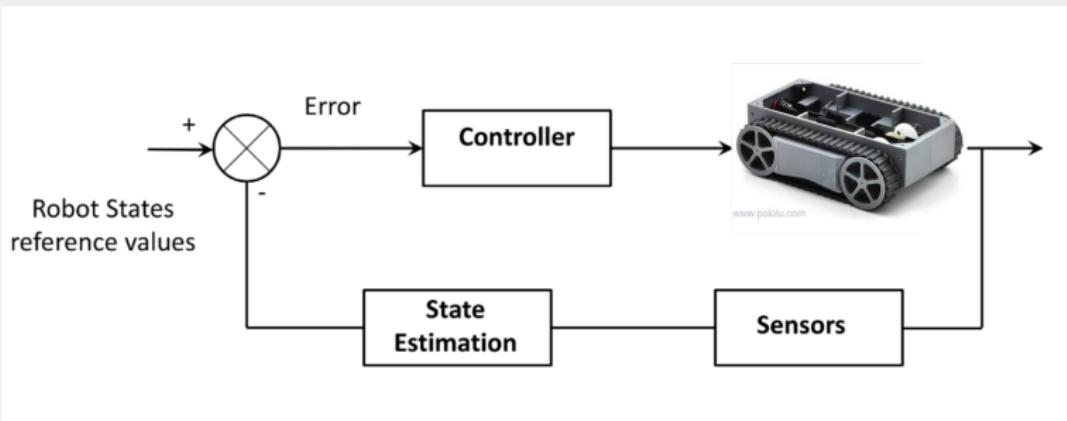
Autonomous Mobile Robots - Roland Siegwart, Margarita Chli, Nick Lawrence

INTRODUCTION

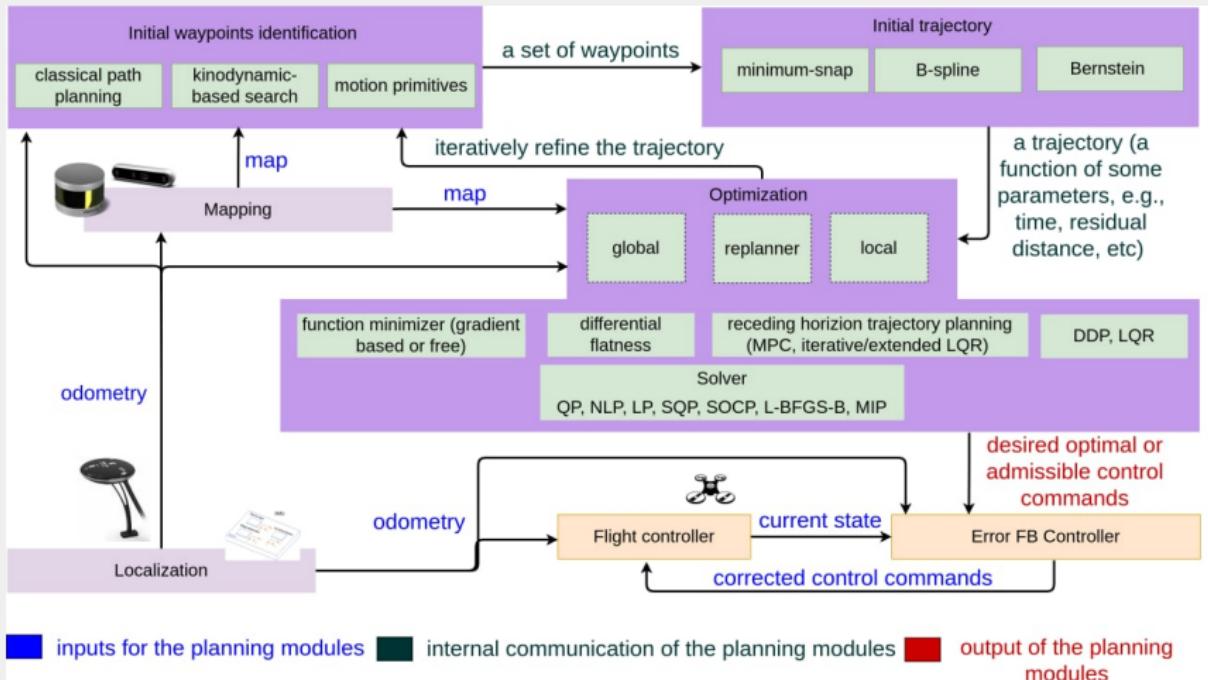


<https://twitter.com/briandouglas/status/1294734347782615040>

INTRODUCTION



INTRODUCTION



CONTROL OF MOBILE ROBOTS

CONTENTS

- Kinematics of wheeled mobile robots: internal, external, direct, and inverse
 - ▶ Differential drive kinematics
 - ▶ Bicycle drive kinematics
 - ▶ Rear-wheel bicycle drive kinematics
 - ▶ Car(Ackermann) drive kinematics
- Wheel kinematics constraints: rolling contact and lateral slippage
- Wheeled Mobile System Control: pose and orientation
 - ▶ Control to reference pose
 - ▶ Control to reference pose via an intermediate point
 - ▶ Control to reference pose via an intermediate direction
 - ▶ Control by a straight line and a circular arc
 - ▶ Reference path control
- Smooth path planning in a given 2-D space for vehicles with nonholonomic constraints using Hybrid A*

BAYESIAN FILTER

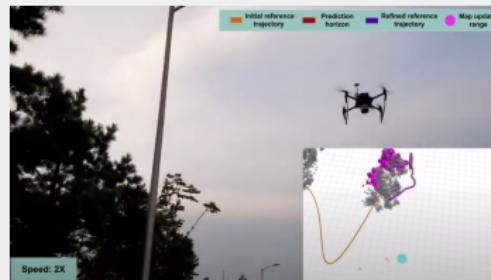
CONTENTS

- Basic of Probability
- Probabilistic Generative Laws
- Estimation from Measurements
- Estimation from Measurements and Controls

KALMAN FILTER

CONTENTS

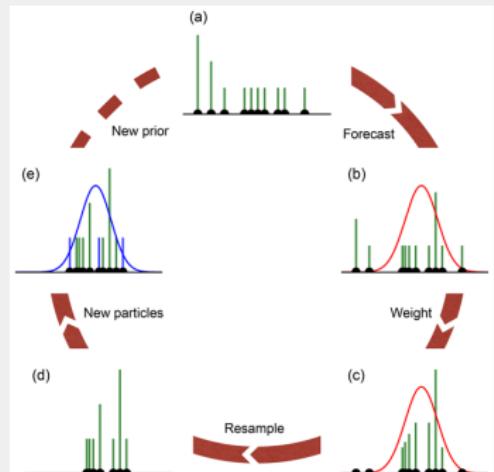
- Gaussian Distribution
- One Dimensional Kalman Filter
- Multivariate Density Function
- Marginal Density Function
- Multivariate Normal Function
- Two Dimensional Gaussian
- Multiple Random Variable
- Multidimensional Kalman Filter
- Sensor Fusion
- Linearization, Taylor Series Expansion, Linear Systems
- Extended Kalman Filter (EKF)
- Comparison between KF and EKF



PARTICLE FILTER

CONTENTS

- A Taxonomy of Particle Filter
- Bayesian Filter
- Monte Carlo Integration (MCI)
- Particle Filter
- Importance Sampling
- Particle Filter Algorithm

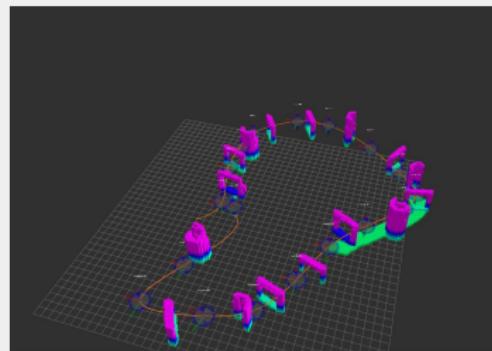


<https://hess.copernicus.org/articles/23/1163/2019/>

ROBOT LOCALIZATION

CONTENTS

- A Taxonomy of Localization Problems
- Markov localization
 - ▶ Environment Sensing
 - ▶ Motion in the Environment
 - ▶ Localization in the Environment
- EKF localization with known correspondence
- Particle filter localization with known correspondence



MULTI-VIEW GEOMETRY

CONTENTS

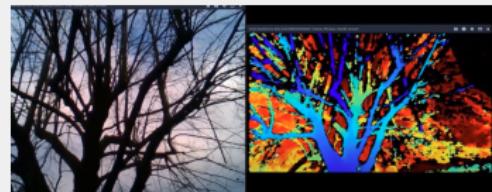
■ Monocular Vision

- ▶ Pinhole Camera Model
- ▶ Image Plane, Camera Plane, Projection Matrix
- ▶ Projective transformation
- ▶ Finding Projection Matrix using Direct Linear Transform (DLT)
- ▶ Camera Calibration

■ Stereo Vision

- ▶ Simple Stereo, General Stereo
- ▶ Some homogeneous properties
- ▶ Epipolar Geometry
- ▶ Essential matrix, Fundamental matrix

■ Depth Estimation



COURSE LOGISTICS

- 23.01 (16:10-17:40) introduction and setting up
- 24.01, 30.01, 31.01, 01.02 (16:10-17:40) quiz1 hw1
- 06.02, 07.02, 08.02, 13.02 (16:10-17:40) quiz2 hw2
- 14.02, 15.02, 20.02, 21.02 (16:10-17:40) quiz3 hw3
- 27.02, 28.02, 07.03, 13.03, 14.03 (16:10-17:40) quiz4 hw4
mini-project release
- 20.03 (16:10-17:40) min-project presentation

COURSE EVALUATION

- In-class activities (10% + 10%)
- Homework 50%
- Mid-term Exam (10%)
- Quizzes 20%

REFERENCES

-  GREGOR KLANCAR, ANDREJ ZDESAR, SASO BLAZIC, AND IGOR SKRJANC.
WHEELED MOBILE ROBOTICS: FROM FUNDAMENTALS TOWARDS AUTONOMOUS SYSTEMS.
Butterworth-Heinemann, 2017.
-  ROLAND SIEGWART, ILLAH REZA NOURBAKHSH, AND DAVIDE SCARAMUZZA.
INTRODUCTION TO AUTONOMOUS MOBILE ROBOTS.
MIT press, 2011.
-  SEBASTIAN THRUN.
PROBABILISTIC ROBOTICS.
Communications of the ACM, 45(3):52–57, 2002.