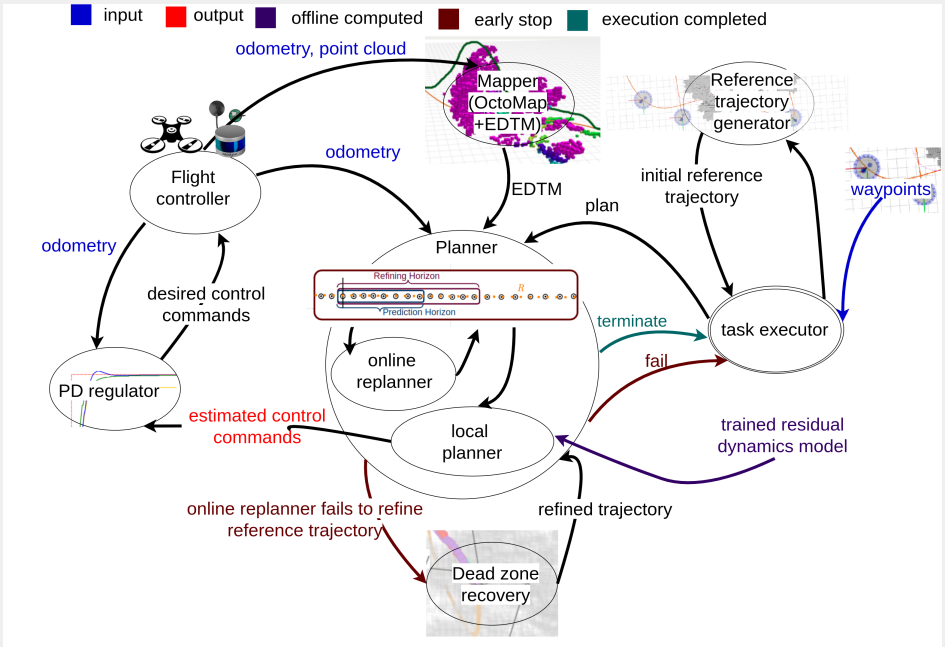
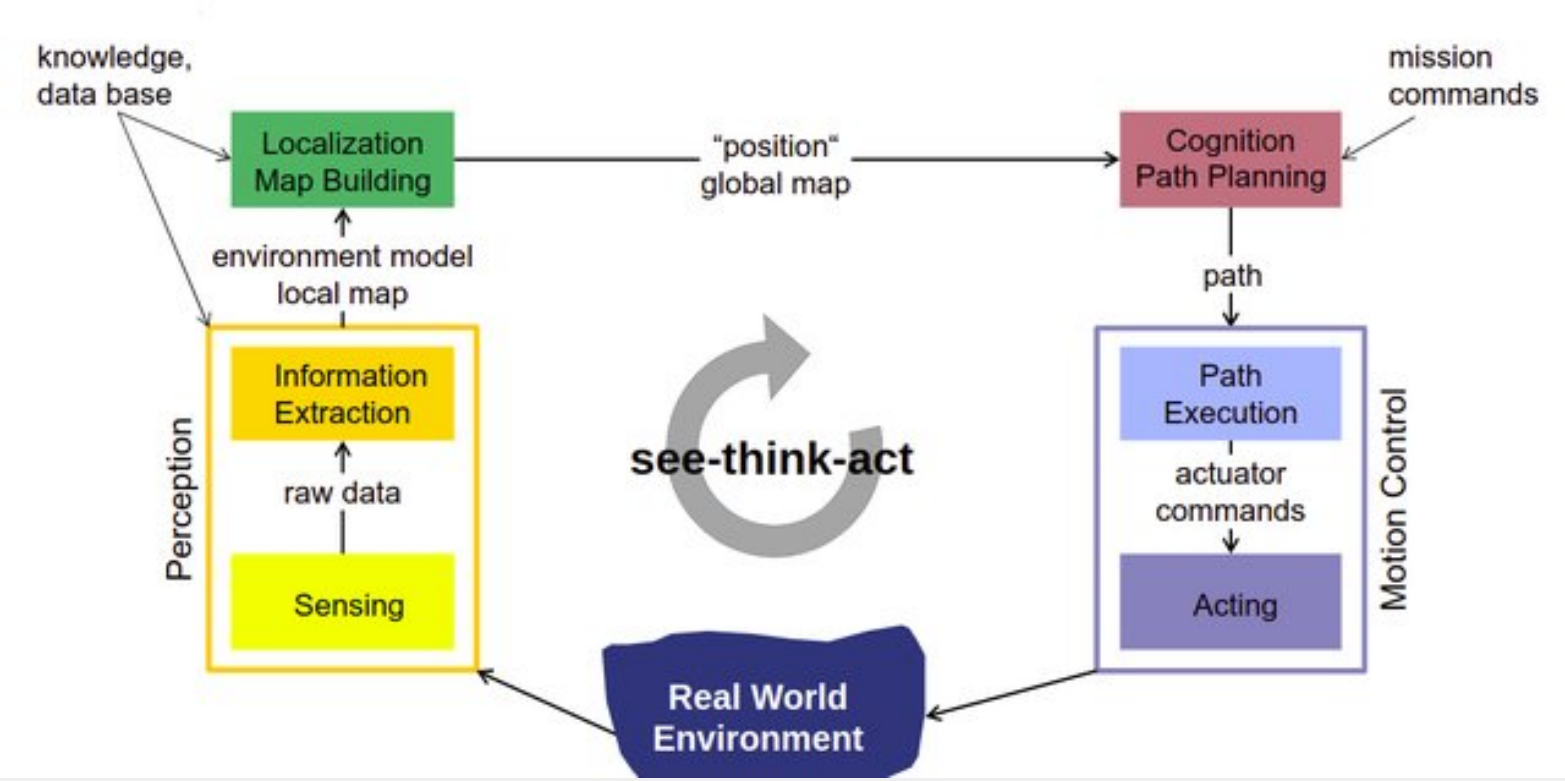
Motion Planning for Autonomous Vehicles

Geesara Kulathunga

February 11, 2023

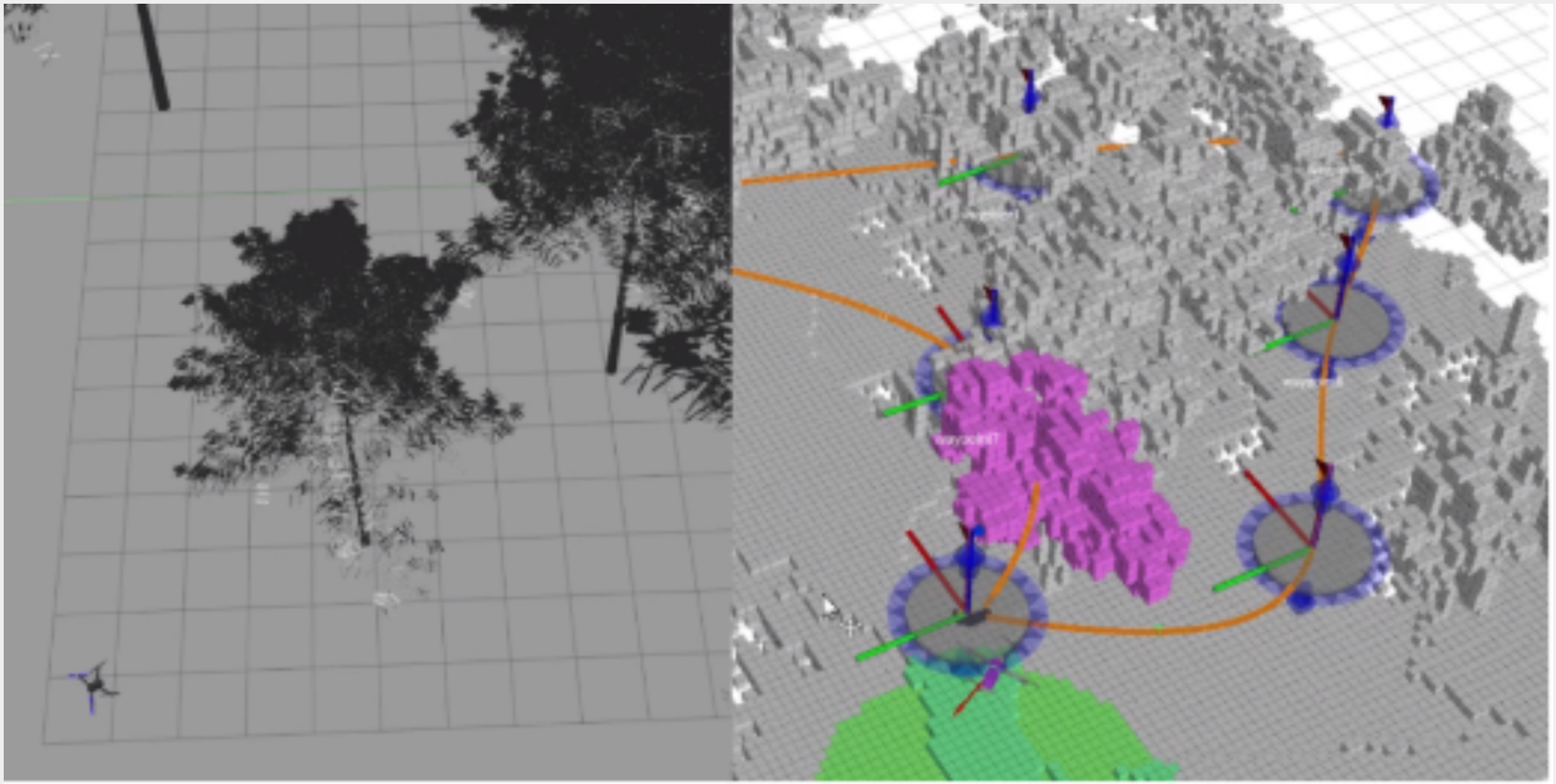


Introduction

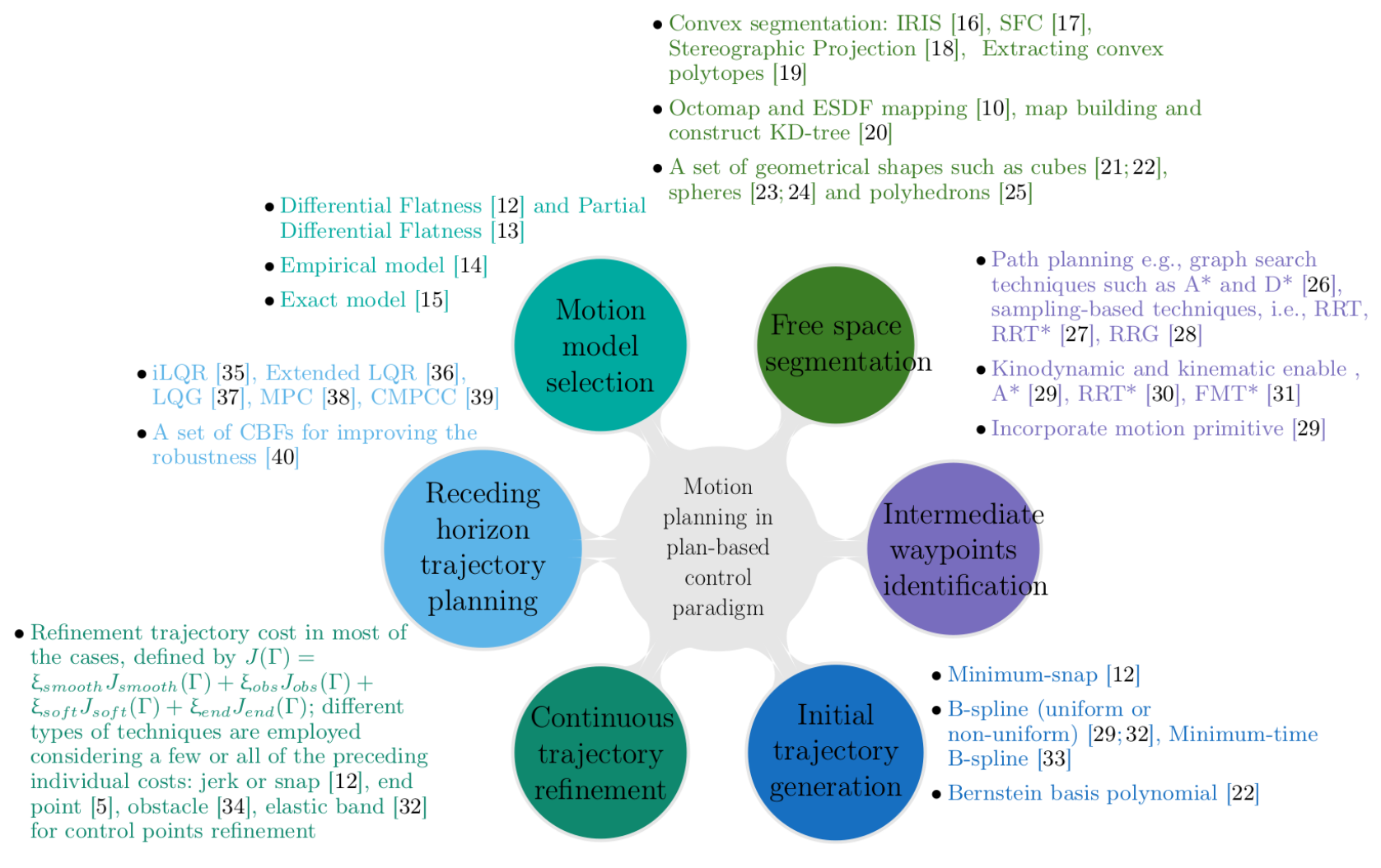


Autonomous Mobile Robots - Roland Siegwart, Margarita Chli, Nick Lawrance

Motion planning in plan-based control paradigm

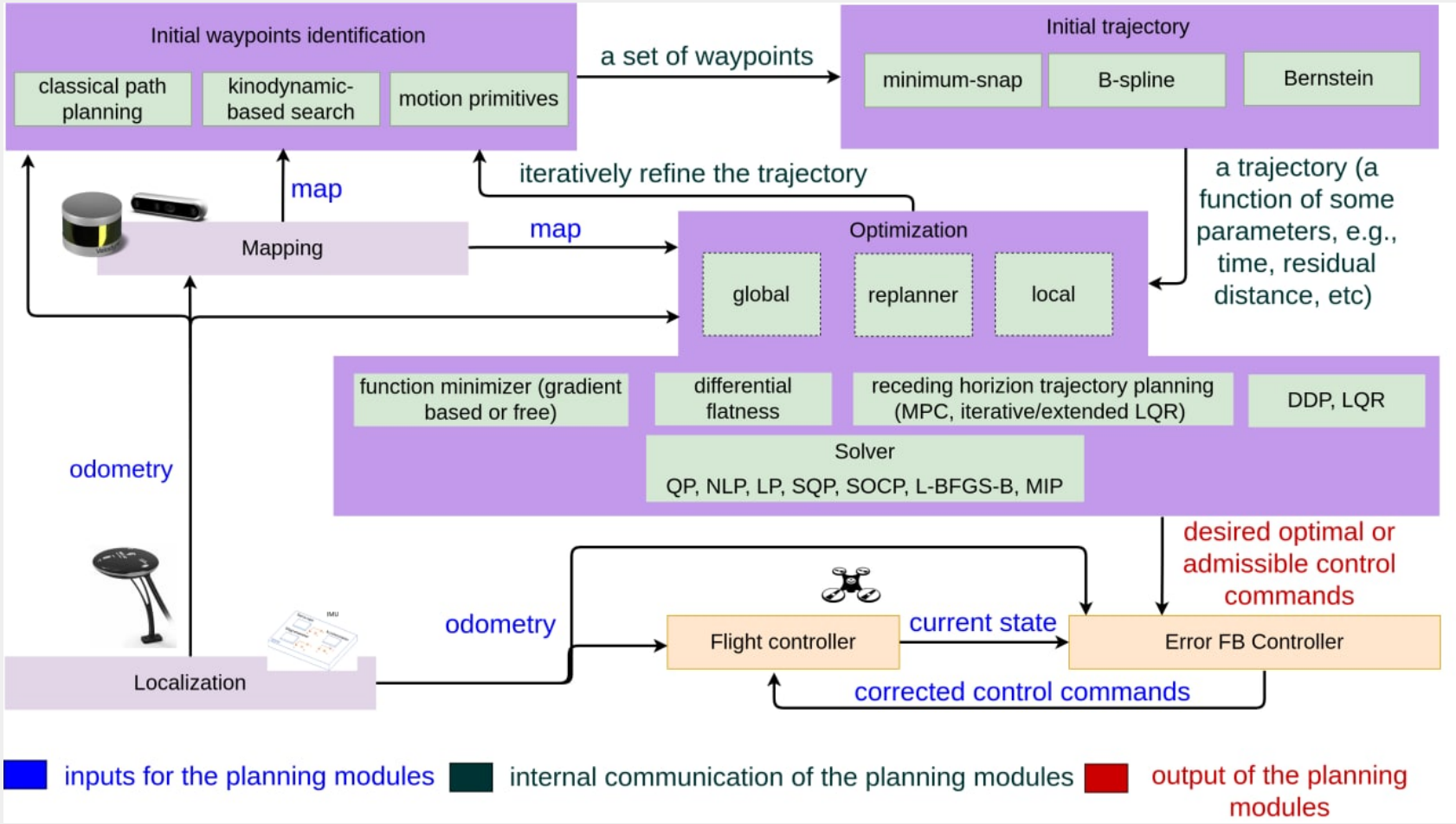


Motion planning in plan-based control paradigm



Kulathunga, G., Klimchik, A. (2022). Optimization-based Motion Planning for Multirotor Aerial Vehicles: a Review. arXiv preprint arXiv:2208.14647

Motion planning in plan-based control paradigm



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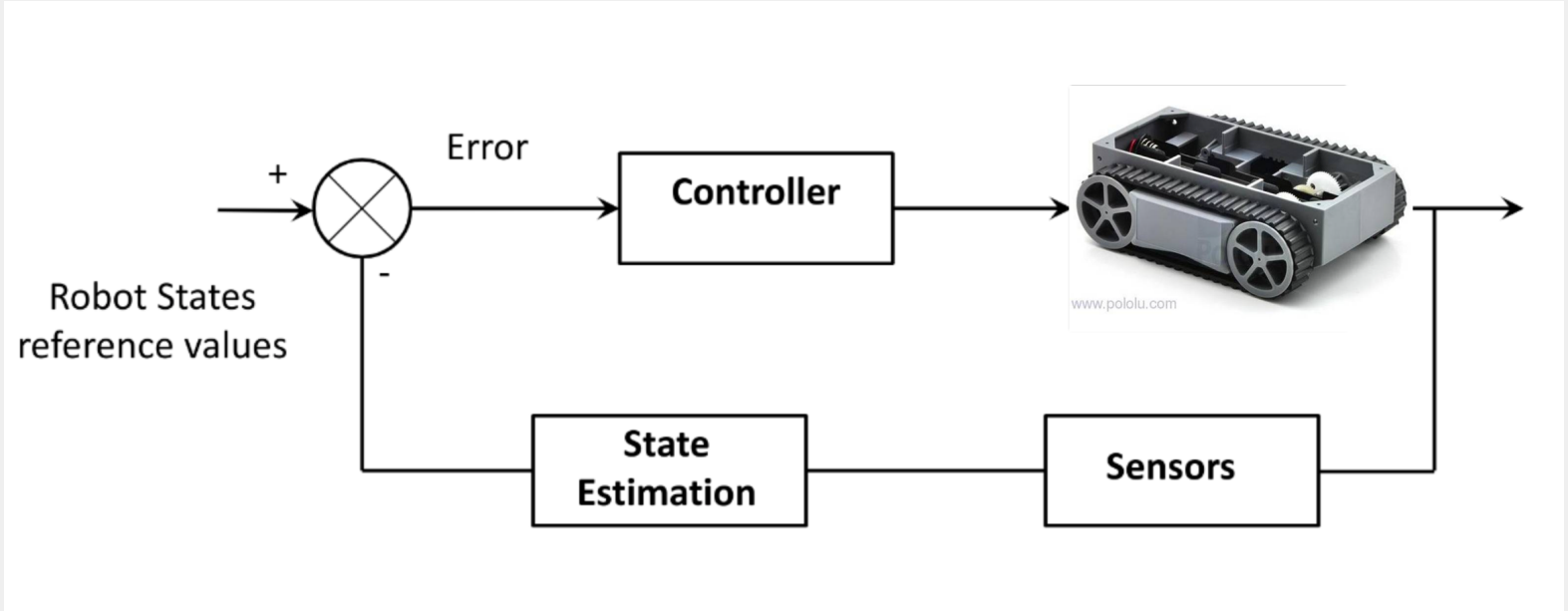
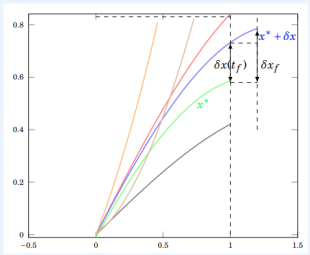


Course Structure

Variation of calculus



Trajectory generation

linear, nonlinear, or piecewise,

- n degree
- Lagrange
- Quintic
- Spline interpolation: Linear, Quadratic, and Cubic Spline
- Bezier
- B-spline
- Smoothing using gradient descent
- Double arc trajectory interpolation

Path Planning

Graph-based

- Depth First Search
- Breath First Search
- Dijkstra's Algorithm
- Greedy Best First Search
- A*
- Hybrid A*
- Kinodynamic A*

Sampling-based

- PRM
- RRT
- RRT*

Optimal Control Problem
(boundary value fixed and varies)

point and differential equations constraints

control constraints

Hamiltonian

Pontryagin's Minimum Principle

Quadratic Programming (QP)

Mixed-integer QP

Nonlinear Programming (NLP)

Model Predictive Control

. Multiple-Shooting
. Direct-Collocation

planning: optimal tracking and regulating

controlling: path tracking control

Frenet frame trajectory planning

Linear Quadratic Regulator

Least squares Hamilton Jacobi Bellman (HJB)

optimal tracking and regulating

Model

discrete
continuous

linear
nonlinear
linearaized

time-varying
time-invarient

Course Logistics

- 11.02 (16:00-17:30) introduction and setting up
- 18.02, 24.02, 25.02, 04.03 (16:00-17:30) hw1 qz1
- 11.03, 18.03, 24.03, 25.03 (16:00-17:30) hw2 qz2
- 01.04, 07.04, 08.04, 14.04 (16:00-17:30) hw3 qz3
- 15.04, 21.04, 22.04, 28.04 (16:00-17:30) hw4 qz4
- 29.04, 05.05, (16:00-17:30) mini-project release
- 06.05 (16:00-17:30) mini-project presentation

Course Evaluation

- In-class activities (5% + 10%)
- Mini-project (5% + 5% +5%)
- Homework (20% + 30%)
- Quizzes 20%

References

Git repo:
`https://github.com/GPrathap/motion_planning.git`