Chapter 1

Abstract

The goal of this project is to implement and test a full-stack racing strategy for single vehicle and head-to-head racing, with a focus on integrating and testing pipeline components. The goal is to create benchmark tests to evaluate each pipeline component.

The chapters are as follows:

1.1 Chapter 1

An overview of the theory. This includes all pipeline components as well as current techniques/methods and algorithms used in the pipeline

1.2 Chapter 2

Literature review

1.3 Chapter 3

Testing for perception

localisation: maximum number of particles computational power sample frequency response to odometry quaility

accuracy- mean error and max error laptime/percentage completion robustness-include noise in input data

1.4 Chapter 4

testing for planning include inaccuarate localistation data

local:

laptime

1.5 Chapter 5

testing for control
laptime

1.6 Chapter 6

general software tests
frequency of readings

1.7 Chapter 7

1.8 Chapter 8

1.9 Chapter 9

Discussion of results

1.10 Chapter 10

Conclusion

Chapter 2

Lit Review

2.1 Perception

2.1.1 Problems

2.2 Planning

2.2.1 Problems

2.3 Control

2.3.1 Problems

Chapter 3

Rough

[1]
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[5]

3.1 Pipeline

3.1.1 Perception

The goal of the perception pipeline is to efficiently provide accurate cone position and color estimates as well as their uncertainties in realtime.[5]

Perception is the general term for all algorithms that perceive the environment and derive knowledge about it. It includes detecting objects, detecting free space, mapping the environment and localizing the autonomous vehicle. [6] defines the fundemtal problems of perception as:

- High speed object detection
- High speed localization and state estimation
- Localization on wide areas without specific landmarks
- Precise localization information necessary to achieve high dynamic trajectory planning and control

Perception algorithms include localization and object detection [6]

Common Localistaion methods:

To do look at all algorithms (1)

simultaneous localization and mapping

Adaptive Monte Carlo Localization

LiDAR distortion compensation

extended H∞ filter

Particle filter ?

[6]

3.1.2 Planning

Planning invloves the algorithms that plan the trajectories for vehicle to drive around the track.[6]

Global Planning Global planning provides an optimal path, better known as raceline, around the racetrack. In the context of racing, global planning often optimize for the lowest lap time. Therefore, when following this raceline, the car drives an optimal path around the racetrack (under the constraints of the raceline generation) as fast as possible. [6]

Local Planning Local planning (or motion planning) plans on a finer granularity compared to global planning, usually under the assumption that an optimal global trajectory is provided. Local planners operate in a certain time horizon, and aim to avoid obstacles while still provide a fast and reliable path that does not deviate too much from the optimal global raceline. [6]

Behavioral Planning Behavioral planning provides information about the high-level mission planning of the racecar. This can include the decision making about overtaking maneuvers (overtaking left/overtaking right/stay behind), the energy management strategy, interaction with other vehicles and the reaction to inputs from race control (e.g., flags, speed limits). [6]

The fundemtal goals of planning are as follows:[6]

- Minimum-time optimization for a global optimal raceline.
- Long local planning horizon for recursive feasibility.
- Obstacle avoidance and vehicle reaction at high speeds
- High re-planning frequency for real-time capability
- Decision making under high uncertainty
- Interaction planning with non-cooperative agents.

3.1.3 Control

To do...

☐ 1 (p. 5): look at all algorithms

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