dubins Documentation

Release 0.10.0

Andrew Walker

Mar 14, 2018

Contents

This software finds the shortest paths, and related information, between configurations for the Dubins' car - a vehicle model that describes a kinematic two-dimensional model of a car that can only drive forward, or turn with a bounded turning radius.

The Dubins' car was originally described L. E. Dubins in *[Dubins57]*, and is important tool for demonstrating concepts in robotics including path planning subject to non-holonomic constraints.

The method used to find paths is based on the algebraic solutions published in *[Shkel01]*. However, rather than using angular symmetries to improve performance, the simpler approach of testing all candidate solutions is used here.

CHAPTER 1

Contents

1.1 Background

Note: A deep understanding of the mathematics of Dubins' curves isn't necessary for making use of this module, but it may help if any changes are required to the module.

The motion of the Dubins' car can be described in terms of the differential equations.

$$\begin{aligned} \dot{x} &= \\ v\cos(\theta) & \\ \dot{y} &= \\ v\sin(\theta) & \\ \dot{\theta} &= \\ \omega & \end{aligned}$$

Where x and y are the position of the vehicle, θ is the angular heading of the vehicle, v is a velocity command input, and ω is the rotational rate input.

Another way of saying this is that the Dubins' car can be described by a configuration $q = [x, y, \theta]^T$.

The forward only constraint on the vehicle is imposed by requiring $0 < v \leq v_{max}$ and the limited turning rate constraint by limiting $|\omega| < \omega_{max}$.

A Dubins' path describes the optimal (shortest path) that satisfies the constraints. These optimal paths can be shown to require $v = v_{max}$ for the whole path and ω is equal to $\pm\omega_{max}$ or 0. Often, the constraints are rewritten (as the equivalent) $v_{max} = 1$ and $\frac{\omega_{max}}{v_{max}}$

1.2 The Dubins API

CHAPTER 2

References

Bibliography

[Dubins57] Dubins, L.E. (July 1957). “On Curves of Minimal Length with a Constraint on Average Curvature, and with Prescribed Initial and Terminal Positions and Tangents”. American Journal of Mathematics 79 (3): 497–516

[Shkel01] Shkel, A. M. and Lumelsky, V. (2001). “Classification of the Dubins set”. Robotics and Autonomous Systems 34 (2001) 179–202