Cost functions

Cost functions (Part a)

0.0/5.0 points (graded)

In this problem we will explore how to design cost functions that make the robot exihibit the kind of behavior we want. For this, we will consider the Dubins car model, which is a very simple model of a vehicle given by the following equations:

$$\mathbf{x} = \begin{bmatrix} x \\ y \\ \psi \end{bmatrix}, \qquad \dot{\mathbf{x}} = f(\mathbf{x}, u) = \begin{bmatrix} \dot{x} \\ \dot{y} \\ \dot{\psi} \end{bmatrix} = \begin{bmatrix} -\sin\psi \\ \cos\psi \\ u \end{bmatrix},$$

where $\mathbf{x}$ is the state of the system and consists of the states x (the x-position), y (the y-position) and ψ (the yaw angle of the vehicle). The control input is u.

(a) For optimal control problems, it is often useful to have cost functions of the form:

$$J = \mathbf{x}(t_f)^T Q_f \mathbf{x}(t_f) + \int_0^{t_f} g(t, \mathbf{x}(t))\, dt$$

where the first term depends only on where the robot ends up (the second term is simply the additive cost structure we saw in lecture). Here, t_f is the final time and Q_f is a symmetric positive semidefinite matrix. Suppose we want the robot to end up with its yaw angle close to 0, but do not care about the final x and y positions. What should we choose Q_f to be (remember to make sure it is symmetric and positive semidefinite)?

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Qf =

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Unanswered

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Cost functions (Part b)

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(b) Now suppose we want the vehicle to end up close to the line $y = 0.5x$, but we do not care exactly where on this line and what yaw angle it ends up in. What should we choose Q_f to be (remember to make sure it is symmetric and positive semidefinite)?

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Qf =
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Unanswered

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Cost functions (Part c)

0.0/5.0 points (graded)

(c) Now suppose we want to end up close to the curve $y = x^2$, and again do not care about the final yaw angle or where exactly on this curve we end up. Is it possible to achieve this given our setup?

- Yes
- No

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