**Congratulations! You passed!**

**TO PASS** 80% or higher

Keep Learning

GRADE
80%

# Quiz 7

**LATEST SUBMISSION GRADE**

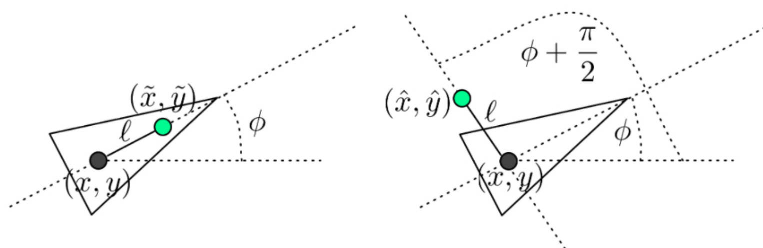
80%

1. In order to make the unicycle

0 / 1 point

$$\begin{aligned}\dot{x} &= v\cos\phi\\ \dot{y} &= v\sin\phi\\ \dot{\phi} &= \omega,\end{aligned}$$

behave like a point-robot, we, in class, focused on a new point $\tilde{x} = x + \ell\cos\phi,\ \tilde{y} = y + \ell\sin\phi$. But, what if we instead were interested in a different point $(\hat{x}, \hat{y})$, as shown below?




The idea behind the abstraction layers is that we would like to plan as if we could control the point $(\hat{x}, \hat{y})$ directly through

$$\begin{aligned}\dot{\hat{x}} &= u_1\\ \dot{\hat{y}} &= u_2.\end{aligned}$$

But, for this to work we need to be able to relate $(u_1, u_2)$ to the actual control inputs of the unicycle. Which of the following expressions correctly relate $(v, \omega)$ to $(u_1, u_2)$?

- (selected) $\begin{bmatrix} v \\ \omega \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & \frac{1}{\ell} \end{bmatrix} \begin{bmatrix} \cos\phi & \sin\phi \\ -\sin\phi & \cos\phi \end{bmatrix} \begin{bmatrix} u_1 \\ u_2 \end{bmatrix}.$
- The point $(\hat{x}, \hat{y})$ is not a good point to chose since there is no way of relating $(v, \omega)$ to $(u_1, u_2)$ directly.
- $\begin{bmatrix} v \\ \omega \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & \frac{1}{\ell} \end{bmatrix} \begin{bmatrix} \cos\phi & -\sin\phi \\ \sin\phi & \cos\phi \end{bmatrix} \begin{bmatrix} u_1 \\ u_2 \end{bmatrix}.$
- $\begin{bmatrix} v \\ \omega \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & \frac{1}{\ell} \end{bmatrix} \begin{bmatrix} \sin\phi & \cos\phi \\ -\cos\phi & \sin\phi \end{bmatrix} \begin{bmatrix} u_1 \\ u_2 \end{bmatrix}.$
- $\begin{bmatrix} v \\ \omega \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & \frac{1}{\ell} \end{bmatrix} \begin{bmatrix} \sin\phi & -\cos\phi \\ \cos\phi & \sin\phi \end{bmatrix} \begin{bmatrix} u_1 \\ u_2 \end{bmatrix}.$

**!** **Incorrect**

2. Consider the car-like robot model in Lecture 7.6. Assume it is driving with a constant steering angle $\psi$. What motion would the car execute, assuming that the translational velocity $v$ is positive but possibly changing over time?

1 / 1 point

- (selected) Drive along a circular arc with radius inversely proportional to $\sin(\psi)$.
- Drive along a circular arc with radius inversely proportional to $\psi$.
- Drive along a circular arc with radius proportional to $\psi$.
- Drive along a circular arc with radius proportional to $\sin(\psi)$.
- We cannot answer this question unless we know more about the translational velocity $v$.

✓ **Correct**

Refer to some past quiz questions + solutions to gain insight on this question!

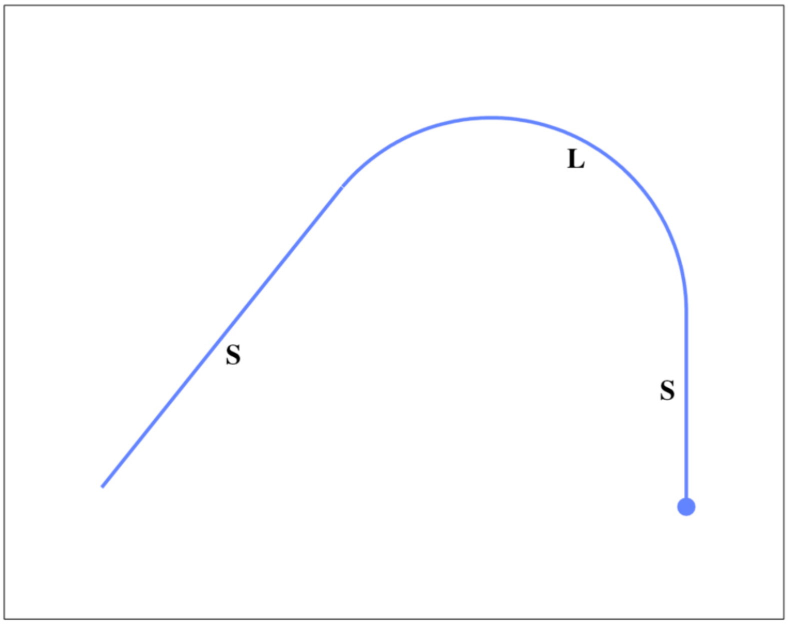
3. The Dubins vehicle model states that

1 / 1 point

$$\dot{x} = v\cos\phi$$
$$\dot{y} = v\sin\phi$$
$$\dot{\phi} = \omega$$
$$v = 1, \;\; \omega \in [-1, 1],$$

i.e., it is a unicycle with speed $v = 1$ and where the angular velocity is bounded. We now know that this means that the Dubins vehicle can only execute maneuvers whose curvature is less than or equal to 1 (max(curvature)=$|\omega/v| = 1/1 = 1$ ).

When solving the problem of moving in the shortest amount of time between two points, it is possible to show that only three ``modes" are used, namely go straight (S) with $\omega = 0$, turn max left (L) with $\omega = 1$, and turn max right (R), with $\omega = -1$. An example of a S-L-S maneuver is shown below, with the robot starting from the solid circle:




Which of the following types of maneuvers could (depending on how long each segment is) possibly move a Dubins vehicle from $(x, y, \phi) = (0, 0, 0)$ to $(x, y, \phi) = (0, 0, \pi)$?

- [x] R-L-S

✓ **Correct**
Draw out each of the listed maneuvers on a coordinate grid to see the behavior.

- [ ] S-R-S
- [ ] R-S
- [ ] L-R
- [x] R-L-R

✓ **Correct**
Draw out each of the listed maneuvers on a coordinate grid to see the behavior.

4. Why do we typically use layered architectures when designing robotic navigation systems?

1 / 1 point

- ○ It makes the navigation problem easier by separating it into a planning phase and a tracking phase.
- ◉ They are all good reasons.
- ○ Different robot types can execute the same high-level navigation strategies.
- ○ It allows for the details of the robot model to be abstracted away at the higher levels of the architecture.
- ○ AI-based planning tools can be more or less directly applied without having to couple them to the robot dynamics.

Correct

Review the concepts covered in lecture during this course....

5. Last question of the entire course -- Which of the following items did not appear anywhere in this course?

**1 / 1 point**

- (●) Teddy bear.
- ( ) Basket ball.
- ( ) Banana.
- ( ) Tortoise.
- ( ) Alien.

**Correct**

Review the concepts covered in this course.....