CS 378: Autonomous Intelligent Robotics

Instructor: Jivko Sinapov

http://www.cs.utexas.edu/~jsinapov/teaching/cs378/
Announcements

Volunteers needed for a demo on 2/19 between 10 am and noon.

Email me if you are interested in helping out
Announcements

FRI Summer Research Fellowships:
https://cns.utexas.edu/fri/beyond-the-freshman-lab/fellowships

Applications are due March 1st but apply now!

Funding is available for 4-5 students per FRI stream
Announcements

Homework 2 is due tonight
Readings for this week


Progression

2D simulation

3D simulation

Real World
Today

1) Behavior-Based Control

2) Subscribing to topics in ROS

3) Representing position and orientation in 3D

4) Homework 3 comes out
“I would especially like to learn about how growing up in different settings affects learning in different ways. ... I am very curious about how growing in a very rural environment—say, the Mongolian steppes—affects learning and development as opposed to growing up in Hong Kong or how growing up in a more impoverished area affects growing up compared to Beverly Hills.”
What should the turtle do?

• Move the turtle (forward or backward)
• Draw a circle
• Add more turtles
• Chase something (another turtle?) in the map
• Respond to text commands
• Control turtle with a mouse
What are some possible behavior primitives?

- Go forward/backward a fixed distance
- Turn, TurnLeft, TurnRight
- KeepPosition
- GoToPosition
- Circle
What should the turtle sense about the world?

- The boundaries of the space
- Its own coordinates and orientation (in ROS when you have position + orientation = pose)
- Other agents or objects
- Color sensor?
Subscribing to ROS topics
Orientation in 2D

- 90° or \( \frac{\pi}{2} \) or \( \frac{2\pi}{4} \) or \( \frac{\pi}{4} \)
- 135° or \( \frac{3\pi}{4} \) or \( \frac{4\pi}{4} \) or \( \frac{\pi}{4} \)
- 270° or \( \frac{3\pi}{2} \) or \( \frac{6\pi}{4} \) or \( \frac{3\pi}{2} \)
- 315° or \( \frac{7\pi}{4} \) or \( \frac{8\pi}{4} \) or \( \frac{2\pi}{2} \)
- 45° or \( \frac{\pi}{4} \) or \( \frac{1\pi}{2} \) or \( \frac{\pi}{4} \)
- 180° or \( \frac{\pi}{2} \) or \( \frac{4\pi}{4} \) or \( \frac{\pi}{2} \)
- 360° or \( \frac{2\pi}{2} \) or \( \frac{8\pi}{4} \) or \( \frac{2\pi}{2} \)
Position and Orientation in 3D
Quaternions
Roll – Pitch – Yaw

[http://www.chrobotics.com/library/understanding-quaternions]
Roll – Pitch – Yaw
Roll – Pitch – Yaw
Converting between Quaternions and RPY

\[
\begin{bmatrix}
\phi \\
\theta \\
\psi
\end{bmatrix} = \begin{bmatrix}
\arctan \frac{2(q_0 q_1 + q_2 q_3)}{1 - 2(q_1^2 + q_2^2)} \\
\arcsin(2(q_0 q_2 - q_3 q_1)) \\
\arctan \frac{2(q_0 q_3 + q_1 q_2)}{1 - 2(q_2^2 + q_3^2)}
\end{bmatrix}
\]

\[
q = \begin{bmatrix}
\cos(\phi/2)\cos(\theta/2)\cos(\psi/2) + \sin(\phi/2)\sin(\theta/2)\sin(\psi/2) \\
\sin(\phi/2)\cos(\theta/2)\cos(\psi/2) - \cos(\phi/2)\sin(\theta/2)\sin(\psi/2) \\
\cos(\phi/2)\sin(\theta/2)\cos(\psi/2) + \sin(\phi/2)\cos(\theta/2)\sin(\psi/2) \\
\cos(\phi/2)\cos(\theta/2)\sin(\psi/2) - \sin(\phi/2)\sin(\theta/2)\cos(\psi/2)
\end{bmatrix}
\]
Traveling Salesman

INPUT

OUTPUT
Traveling Salesman

**Brute-Force Solution:**
$O(n!)$

**Dynamic Programming Algorithms:**
$O(n^2 2^n)$

**Selling on eBay:**
$O(1)$

*Still working on your route?*

*Shut the hell up.*
Homework 3

• The main task consists of making the turtle visit a set of points in the environment
• The behavior needs to be semi-intelligent, i.e., the turtle needs to actively decide which point to visit next
• Your program will need to log the total distance traveled by the turtle and the time it took the turtle to visit every point
Homework Brainstorm

• How should the problem be broken down?
• How can the turtle detect that it has reached a desired position?
THE END