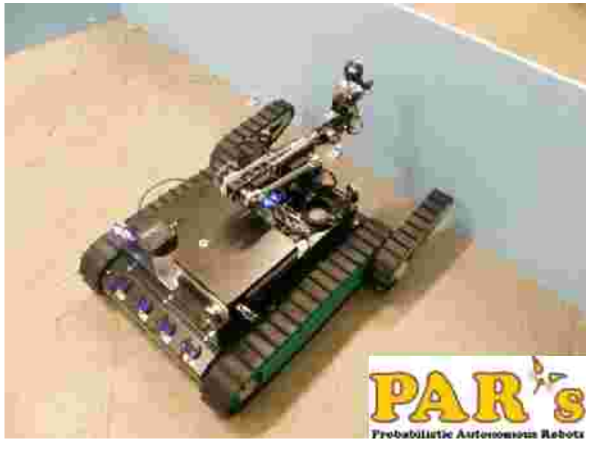
Probabilistic Robotics



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Room 130

Orgazinational

Lecture:
Thursday 13:00 – 15:50

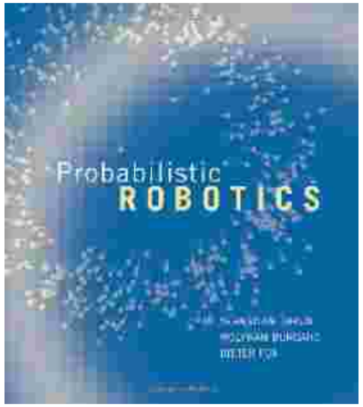
Office Hours:
Tuesday 13:00-14:00
Thursday 11:00-12:00

Exams: 1 Midterm (%20), 1 Final (%30)
Assignments and midterm projects (%50)

Course Meterial

Sebastian Thrun, Wolfram Burgard and Dieter Fox, Probabilistic Robotics, The MIT Press, 2005.

http://www.probabilistic-robotics.org/



ROS Framework

ROS is an open-source, meta-operating system for your robot. It provides the services you would expect from an operating system, including hardware abstraction, low-level device control, implementation of commonly-used functionality, message-passing between processes, and package management. It also provides tools and libraries for obtaining, building, writing, and running code across multiple computers. ROS is similar in some respects to 'robot frameworks,' such as Player, YARP, Orocos, CARMEN, Orca, MOOS, and Microsoft Robotics Studio.

http://www.ros.org/wiki/ROS/Tutorials

Python & C++.

ROS is the Robot Operating System, originally from Stanford and now supported by Willow Garage. ROS has a mature Python interface and is being used around the world by both amateur and professional roboticists

http://python.org/

LaTeX

LaTeX is a high-quality typesetting system; it includes features designed for the production of technical and scientific documentation. LaTeX is the de facto standard for the communication and publication of scientific documents. LaTeX is available as free software. ,

http://www.latex-project.org/guides/

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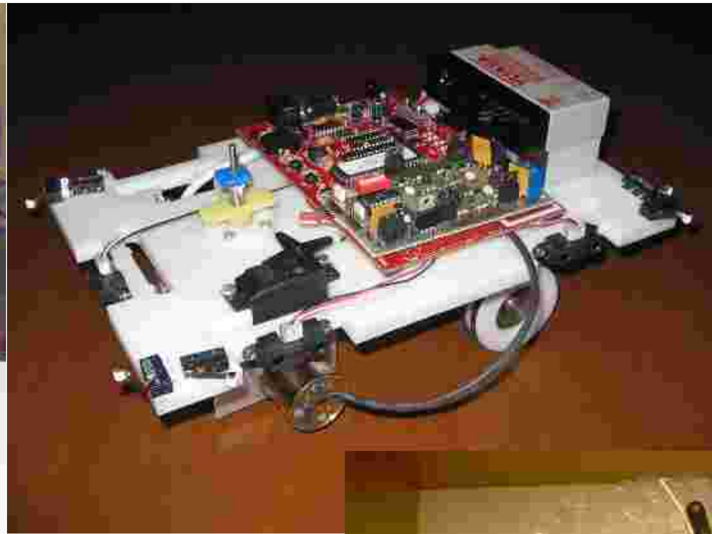
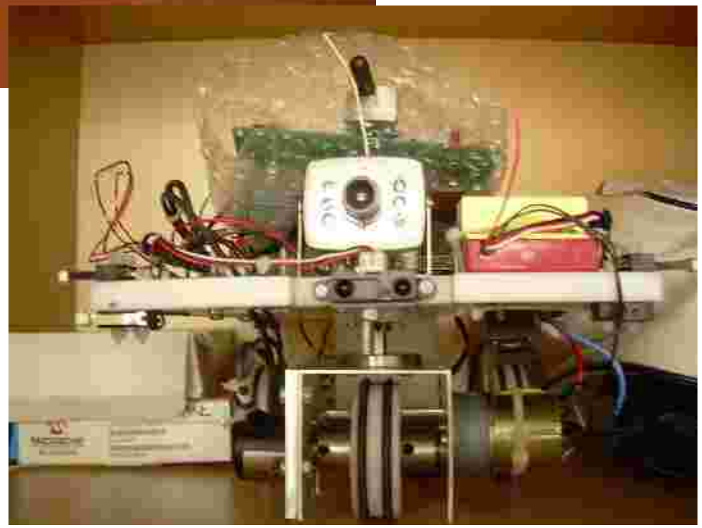
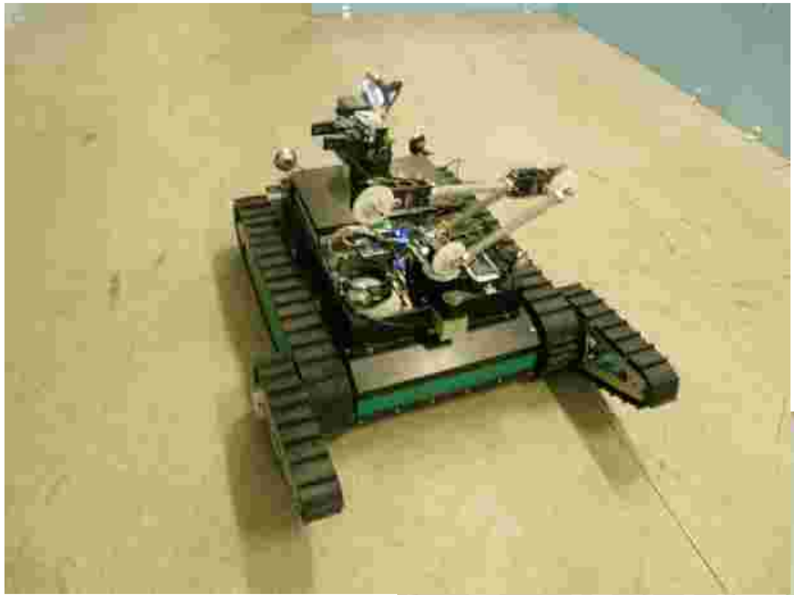






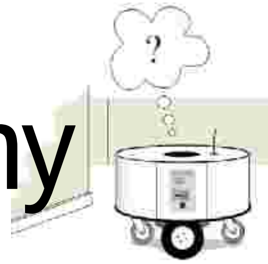
Robot Pose

- 2D world (floor plan)
- 3 DOF : $x, y,$

the pose is a vector containing the x and y coordinates of the robot along with the orientation, theta

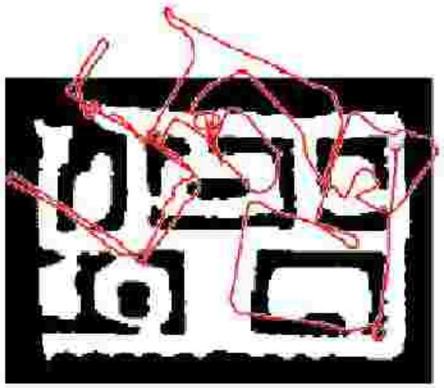
Very simple model—the difficulty is in autonomy

Major Issues with Autonomy



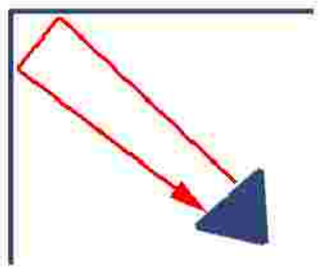
Movement

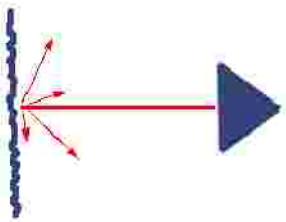
Inaccuracy



Sensor

Inaccuracy





Environmental

Uncertainty

Robot Navigation

Fundamental problems to provide a mobile robot with autonomous capabilities:

- Where am I going ← Mission Planning
- What's the best way there? ← Path Planning
- Where have I been? à how to create an environmental map with imperfect sensors? ← Mapping
- Where am I? à how a robot can tell where it is on a map? ← Localization
- What if you're lost and don't have a map? ← Robot SLAM

Problem One: Localization

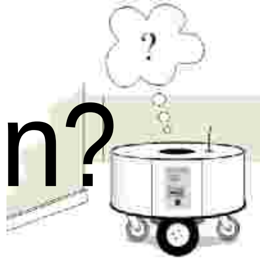
Given:

- World map
- Robot's initial pose
- Sensor updates

Find:

- Robot's pose as it moves

How do we Solve Localization?



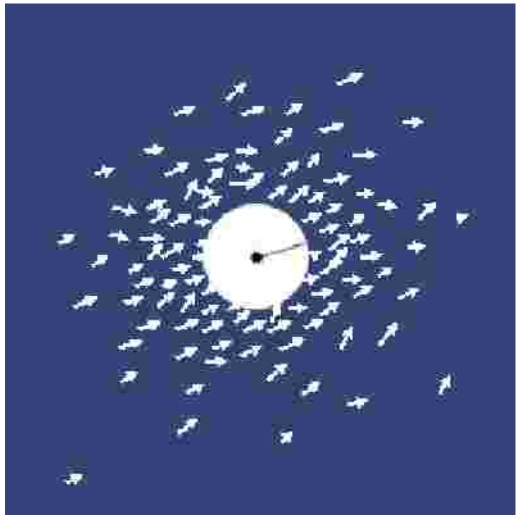
- Represent beliefs as a probability density
- Markov assumption

  Pose distribution at time t conditioned on:

  pose dist. at time t-1

  movement at time t-1

  sensor readings at time t



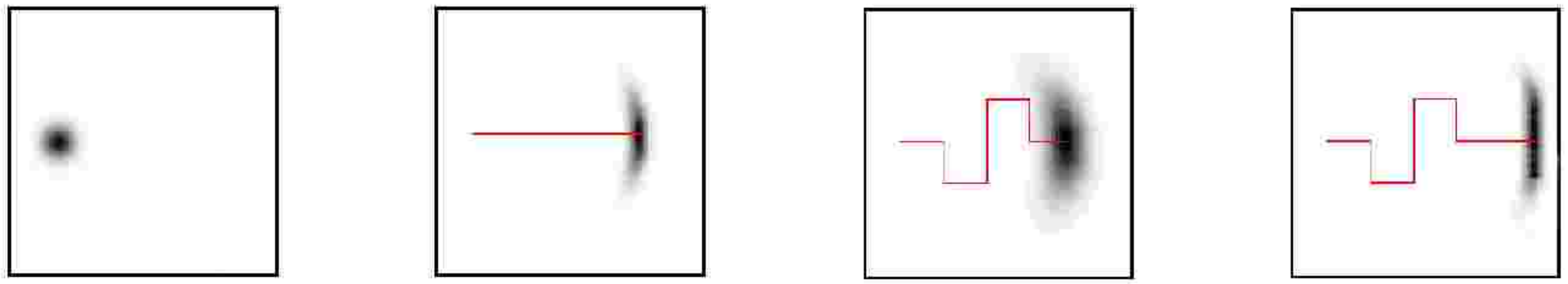
- Discretize the density by sampling

Localization Foundation

At every time step t:

UPDATE each sample's new location based on movement

RESAMPLE the pose distribution based on sensor readings



Algorithms

- Markov localization (simplest)
- Kalman filters (historically most popular)
- Monte Carlo localization / particle filters

Same: Sampled probability distribution
Basic update-resample loop

Different: Sampling techniques
Movement assumptions

Localization’s Sidekick: Globalization

- Localization without knowledge of start location

Credit to Dieter Fox for this demo

Global robot localization using sonar sensors

This example shows the ability of particle filters to represent the ambiguities occurring during global robot localization. The animation shows a series of sample sets (projected into 2D) generated during global localization using the robot's ring of 24 sonar sensors. The samples are shown in red and the sensor readings are plotted in blue. Notice that the robot is drawn at the estimated position, which is not the correct one in the beginning of the experiment.

- One step further: “kidnapped robot problem”

Problem Two: Mapping

Given:

- Robot
- Sensors

Find:

- Map of the environment

  (and implicitly, the robot's location as it moves)

Simultaneous Localization And Mapping (SLAM)

If we have a map:

We can localize!

If we can localize:

We can build a map!

Circular Error Problem

If we have a map:
We can localize!

NOT THAT SIMPLE!

If we can localize:
We can make a map!

Assignment

- Reading : pages 1- 26 of the book
- Writing: Summarize what you have learned using Latex
- due in next Thursday