Introduction to Robotics

CSCI/ATRI 4530/6530

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A quick recap

Course Syllabus

We will broadly cover the following topics:

- Overview of Robotics
- Sensing and Perception
- Locomotion of a robot
- Localization
- Mapping
- Applications - through the project assignments

Course textbook

Textbook

Introduction to Autonomous Mobile Robots, 2nd Ed. (2011), MIT Press. Roland Siegwart, Illah Reza Nourbakhsh, and Davide Scaramuzza

Online lectures available at EdX - Autonomous Mobile Robots (AMRx)

`https://www.edx.org/course/autonomous-mobile-robots`

I will use the slides from this online course in our class

Recommended additional book(s)

Probabilistic Robotics (2005). Sebastian Thrun, Wolfram Burgard and Dieter Fox, MIT Press. ISBN: 9780262201629

Learning ROS for Robotics Programming. E. Fernandez, L.S. Crespo and A. Mahtani, 2nd Edition

Course format

Lectures + Practicum + Assignments

Lectures - theory and basics (will upload all lecture slides and additional materials in eLC after every class)

Practicum - **Robot Operating Systems (ROS)** - programming (C++/Python)

Evaluation:

- Assignments (45%) - both theoretical and practical exercises
- Exams - one midterm (20%) and one final (30%)
- Attendance and participation in class (5%)

Undergraduate and graduate students will be assessed separately. Final letter grade will depend on class standing.

Academic integrity and honesty - strictly followed

Office hours

Tuesday and Thursday 2 - 3 pm (no need to email me before)

OR by prior email appointment

Email: ramviyas@uga.edu

Office: 519 Boyd GSRC

Overview of Robotics

Overview of Robots

Robots are physical agents that perform tasks by manipulating the physical world

Sensors (cameras, lasers) - to perceive the environment

Actuators (legs, wheels, joints, grippers) - assert physical forces on the environment

Categories of robots:

- Manipulators (robot arms) - most common type of industrial robots
- Mobile robots - UGV, UAV, USV, planetary rovers, etc.
- Mobile manipulators - Humanoids robots, mobile robot with arm, etc.
- Others - Assistive robots (prosthetics), soft robots, exoskeletons, etc.

Basics of Autonomous Robots

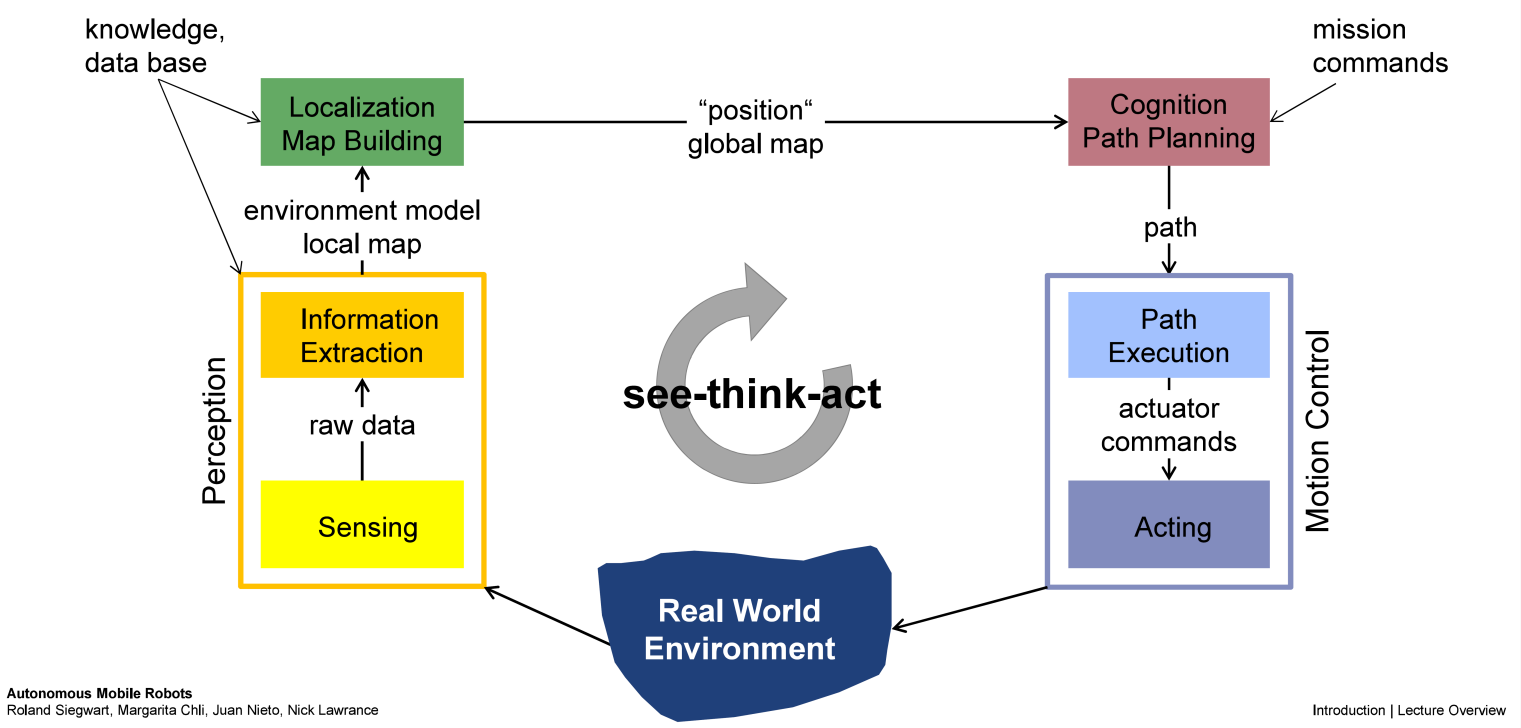
For a robot to be autonomous, it has to know

- Where it is within its environment?
- Where to go?
- How to go from point A to point B?

To answer these questions, the robot has to

- understand its environment - **sensing and perception**
- find its position/state within the environment - **localization**
- expand the knowledge of its environment - **mapping**
- plan and move towards the given goal - **navigation**

Sense-compute-move cycle



Brief history of Robotics

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- (1978) - PUMA robot - developed by Unimation - established the standard in robotic manipulation for assembly tasks

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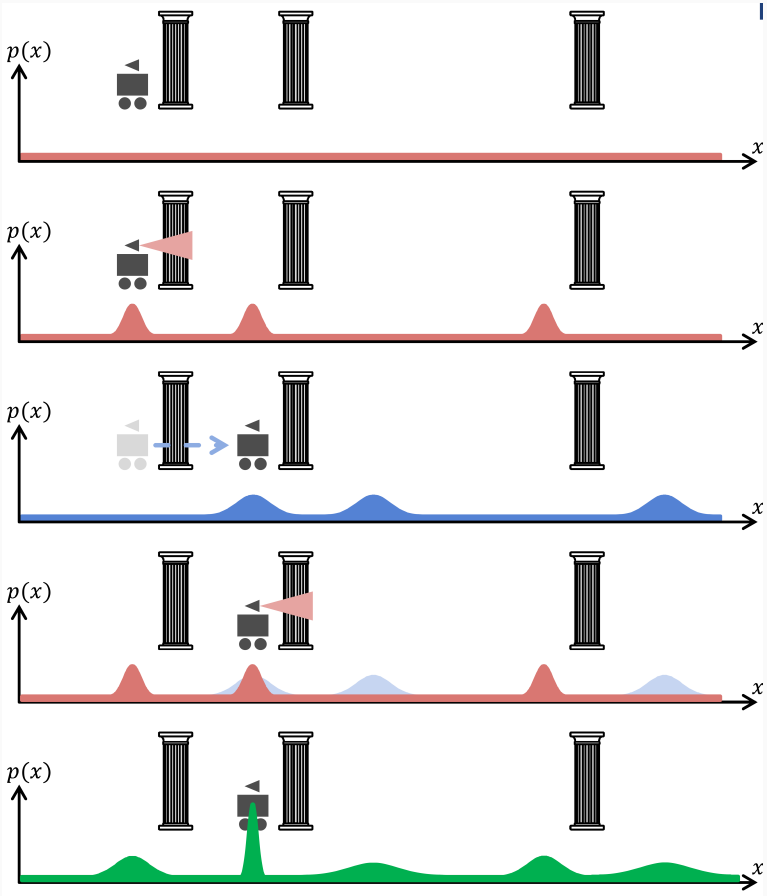
- Drivers for robotics research - DARPA grand challenge, Robocup competitions, etc.

Probablistic localization

Localize the robot in a given map dealing with uncertain data

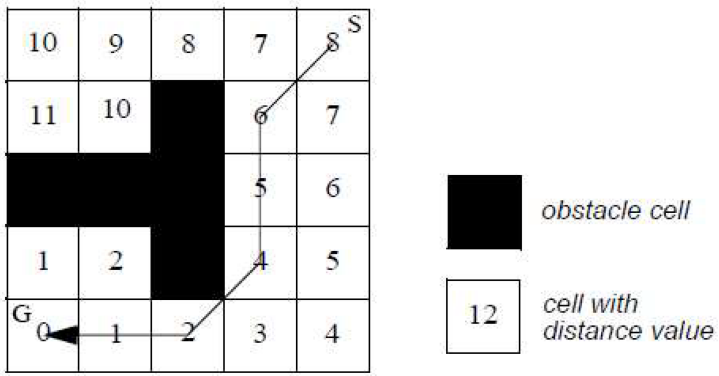
Updates its belief state (fusing information from various sensors - laser scanner, wheel odometer, etc.)



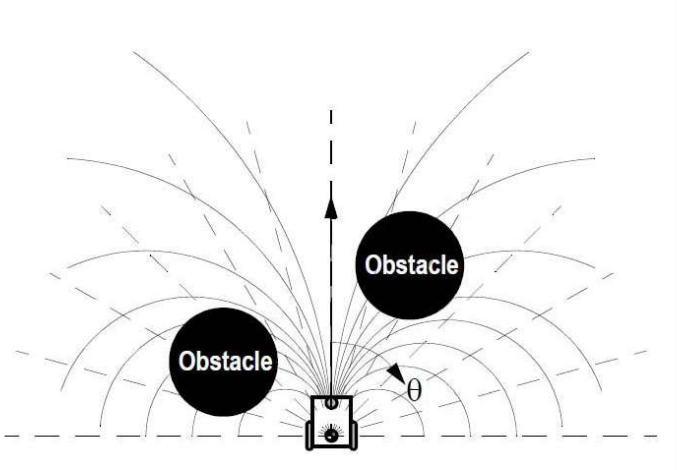
Path planning

Example: Grid cell decomposition of workspace

Global Path Planning - through a map-based planning algorithm



Local Path planning - through obstacle avoidance algorithms



Sensing and perception hardware

Basics of sensors

See the attached slides from EdX

Kinematics of wheeled mobile robots

Basic kinematics

See the attached slides from EdX

For the next class

Next class

- Probability theory basics
- Robot Operating Systems (ROS) basics
- Some robotic applications