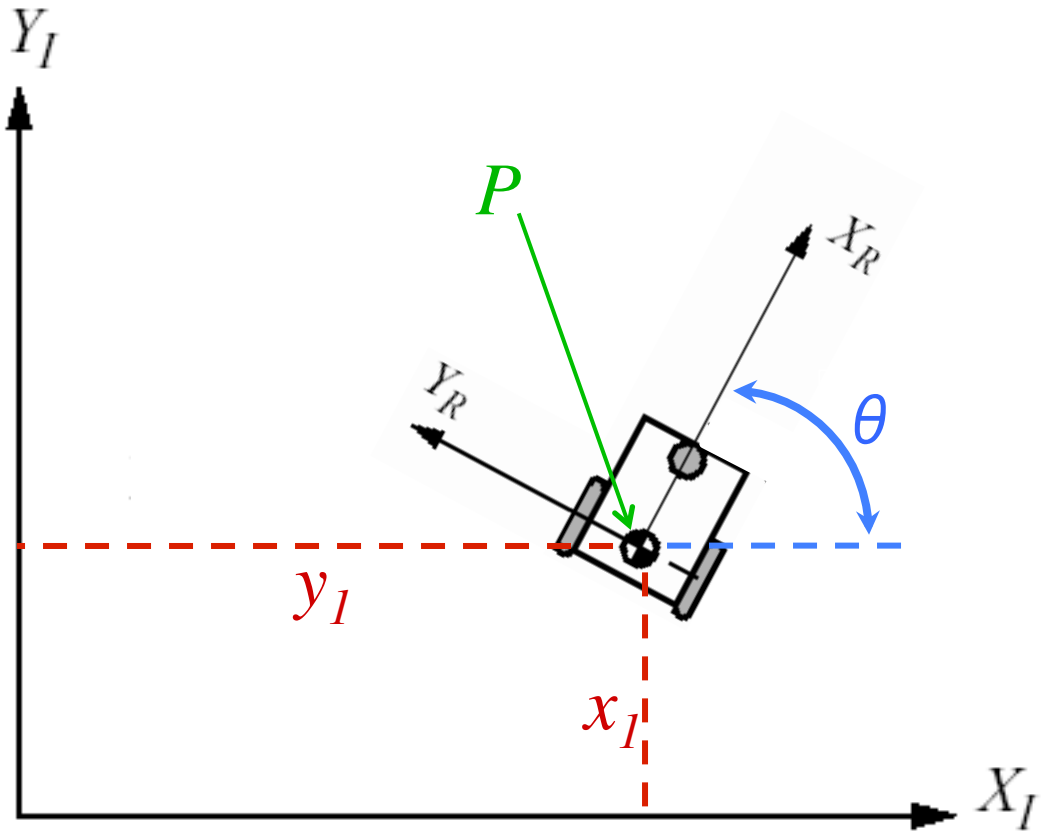
Kinematics

Overview



A Talk!

UMBC CSEE Colloquium
12:00pm Friday, 9th October
ITE325b

Grounded Language Acquisition: A Physical Agent Approach

Dr. Cynthia Matuszek, UMBC Computer Science & Electrical Engineering

For computers to understand human language, first there must be a mapping between words or ideas and the external, physical world. While this is a long-standing problem, advances in robotics have recently made it possible for computers to interact directly with tangibly grounded things. In this talk I describe how we combine robotics and natural language processing to acquire physically grounded language – specifically, how robots can learn about the world from interactions with users, making it possible for them to interact in an intuitive, natural way. I will describe applications of our work and discuss near-term challenges.

Bookkeeping

- Assignment 2 posted
- Upcoming:
  - Quiz 2: Blackboard
- Reading: SNS 3.1, 3.3; CB section 1
- Today: Kinematics; next milestone!

Assignment

1) Simulate a Husky Model in an empty world in a Gazebo environment

2) Add one obstacle to the environment

3) Attach the model with a Kinect sensor to view objects in 3D (with openni Kinect)

4) Simulate that the husky model wanders around and avoids collisions with the obstacle.

Expected Result : 'rosbag info' result

Kinematics

- What is kinematics?
  1. The study of the **motion of objects.**
  2. The study of the geometrically possible motion of a body or system of bodies without consideration of the causes and effects of the motions
- Movement determines the (eventual) position and orientation of the robot
  - Mobile: position and orientation wrt. an arbitrary initial frame
  - Manipulator: position and orientation of end effector*
- Where are we? How did we get there?

Manipulator Kinematics

- *Position* and *orientation* of the robot
  - Mobile: position and orientation wrt. an arbitrary initial frame
  - Manipulator: position and orientation of end effector
- **Forward kinematics:** from parameters to configuration
- **Inverse Kinematics (IK):** from a desired configuration to parameters that make it so

Forward Kinematics

- *Position* and *orientation* of the
  - Mobile: robot center
  - Manipulator: end effector*
- Forward Kinematics (angles to position)
  - What you are given:
    - The length of each link
    - The angle of each joint
  - What you can find:
    - The position of any point
    - (i.e. its (x, y, z) coordinates

** The useful bit at the end that does stuff*

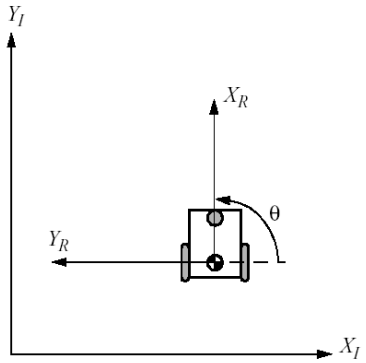
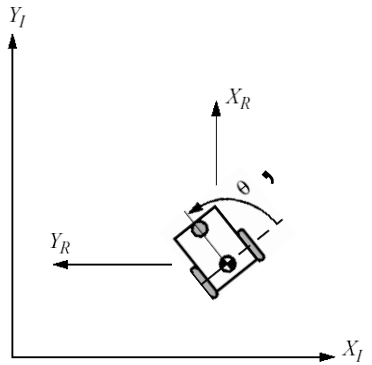
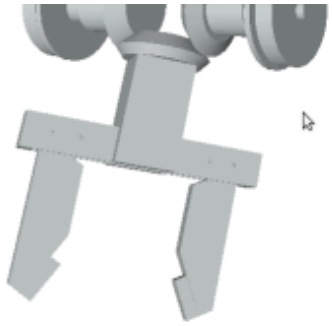
Inverse Kinematics

- *Position* and *orientation* of the
  - Mobile: robot center
  - Manipulator: end effector*
- Inverse Kinematics (position to angles)
  - What you are given:
    - The length of each link
    - The position of some point on the robot
  - What you can find:
    - The displacement of each joint needed to obtain that position

Mobile Robot Kinematics

- Description of mechanical behavior of the robot for design and control
  - Similar to manipulator kinematics
- However, mobile robots can move unbound with respect to its environment
  - there is no direct way to measure the robot's position
  - Position must be integrated over time
  - Leads to inaccuracies of the position (motion) estimate
    → the number one challenge in mobile robotics

Sidebar: Position and Orientation

	Where is it?	What's its orientation?
Mobile	On an $\{x,y\}$ plane 	Heading θ 
Manipulator	In some $\{x,y,z\}$ space 	$\{r/p/y\}$ of end effector 

Mobile Position & Orientation

Frames of reference:

$\{X_I, Y_I\}$: Global
$\{X_R, Y_R\}$: Robot

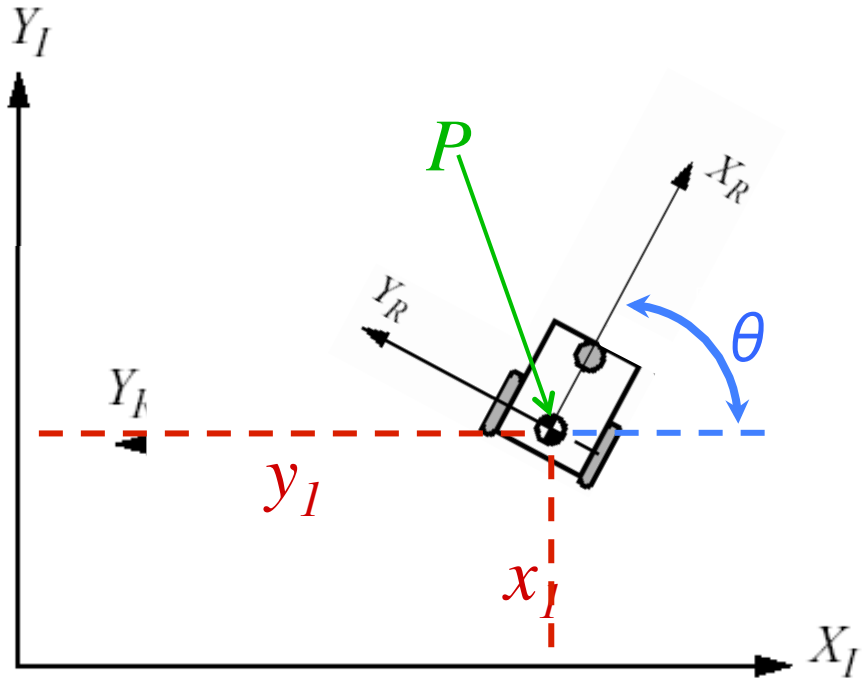
Robot: point P

Position (of P):

$\{x_{I,1}, y_{I,1}\}$

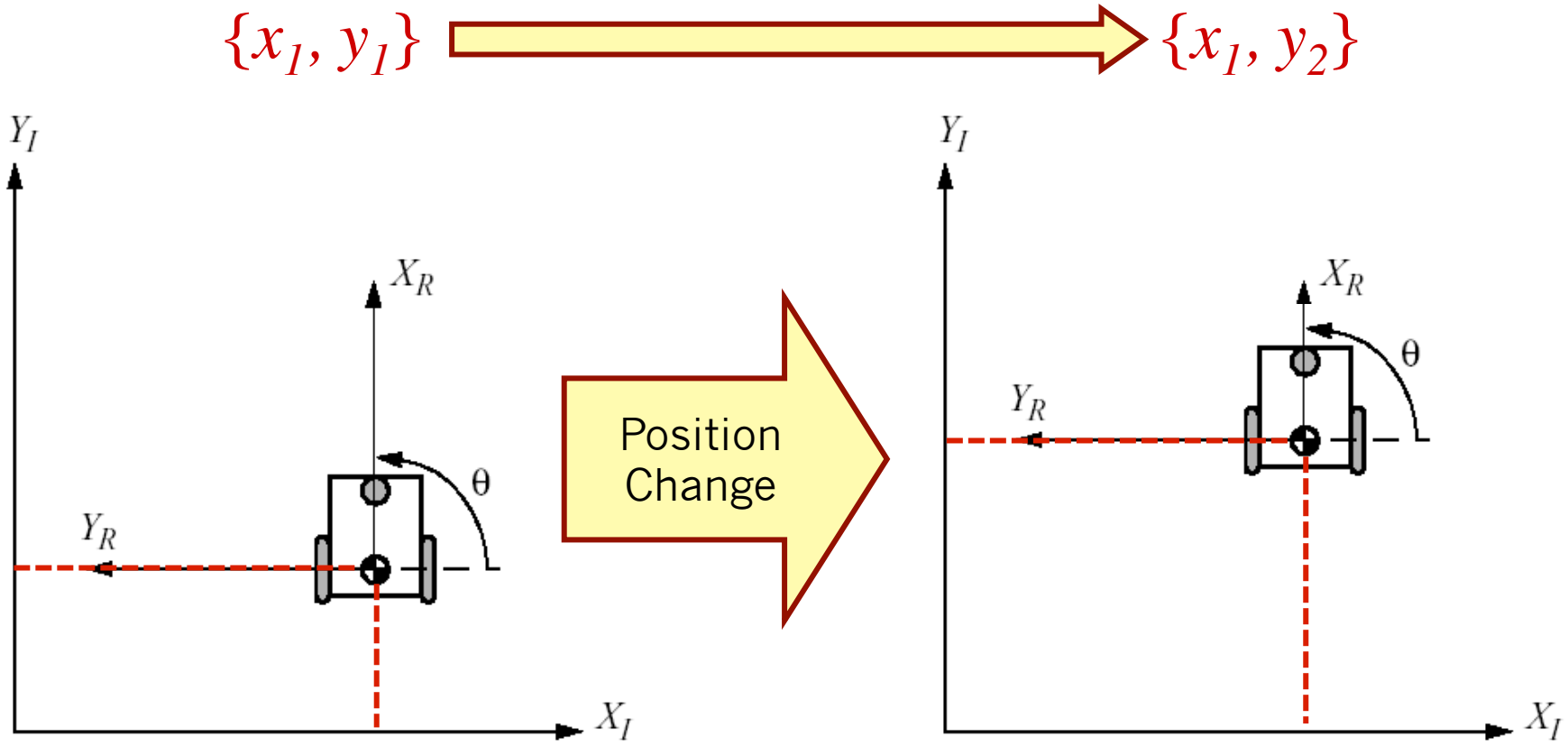
Heading:

$\{\theta\}$: I ∠ R

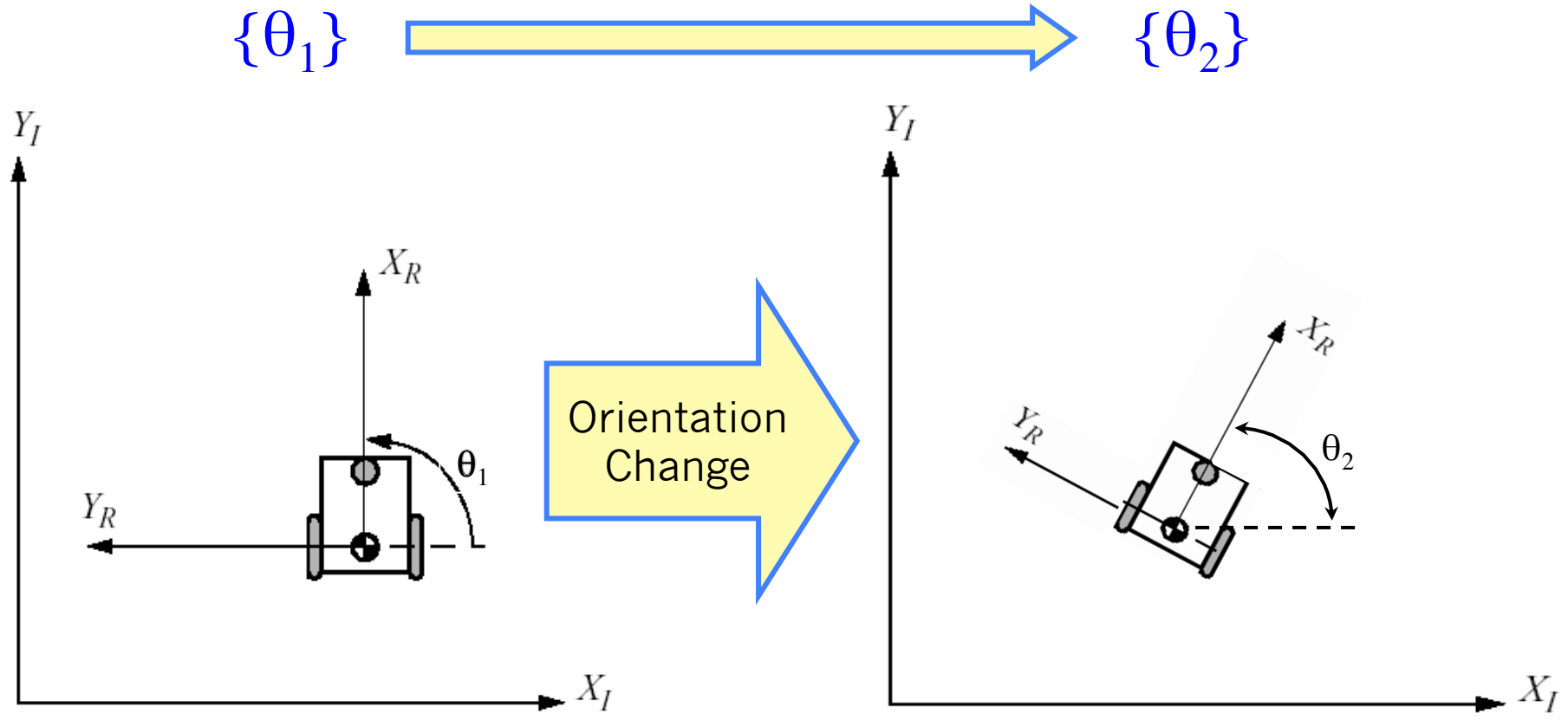


$$\xi_I = \begin{bmatrix} x \\ y \\ \theta \end{bmatrix}$$

Mobile Position Change



Mobile Orientation Change



Mobile Position & Orientation

Frames of reference:

$\{X_I, Y_I\}$: Global
$\{X_R, Y_R\}$: Robot

Robot: point P

Position (of P):

$\{x_{I1}, y_{I,1}\}$

Heading:

$\{\theta\}$: I ∠ R