Locomotion and Manipulation

Chapter 2

Warm-up assignment

- Some great examples of robots and business ideas!
- Lessons learned
  1. Its very unlikely that robots will do something that we do not already do (seamless transition)
  2. If it would not be difficult to realize, we would already have it (risks)
  3. Robotics act in the physical world, so we need to validate them *experimentally*

Peer-to-Peer Grading

- 80% for your work, 20% for grading others
- Grading scoring
  - Penalty for not grading others
  - Penalty for grading different than others
- TAs will provide final grade by adopting peer grades or overriding
- Statistics
  - 57 total, 54 submitted homework, 39 assessed
  - 38/54 left as is, 19 overrides (11 more than 2 points)
  - 13 up, 6 down
- The system works, even without TA (random fluctuations will average out)

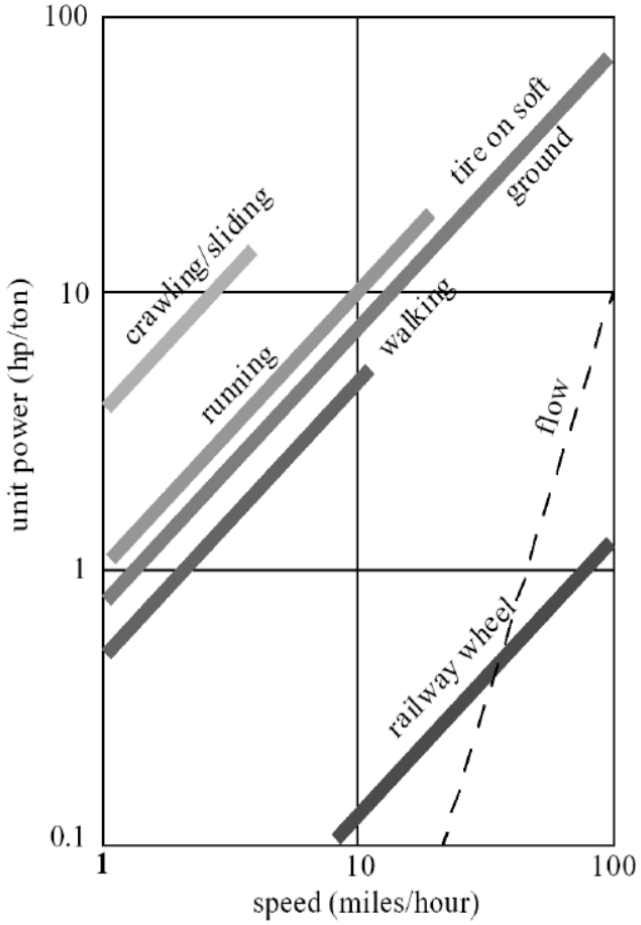
A	94-100
A-	90-93
B+	87-89
B	84-86
B-	80-83
C+	77-79
C	74-76
C-	70-73

Brainstorming

- What are all the different ways a robot could move in its environment?
- Find examples online…

Locomotion

- **Rolling**
- Walking
- Running
- Jumping
- Sliding
- Crawling
- Climbing
- Swimming
- Flying



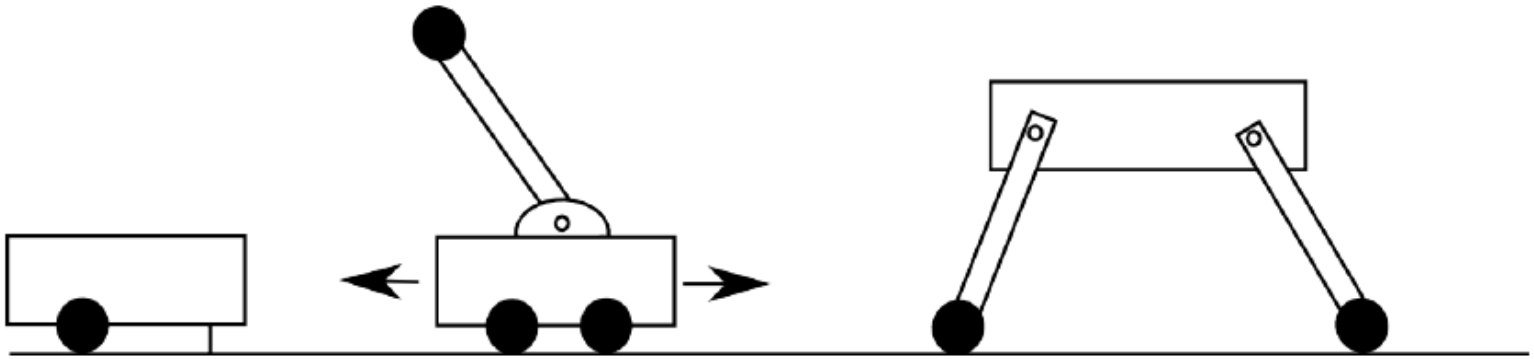
Other actuators

- Electric motor (turns)
  - (brushless) DC
  - Stepper
- Linear actuator
  - Electric
  - Pneumatic
  - Hydraulic
  - Many specialty actuators

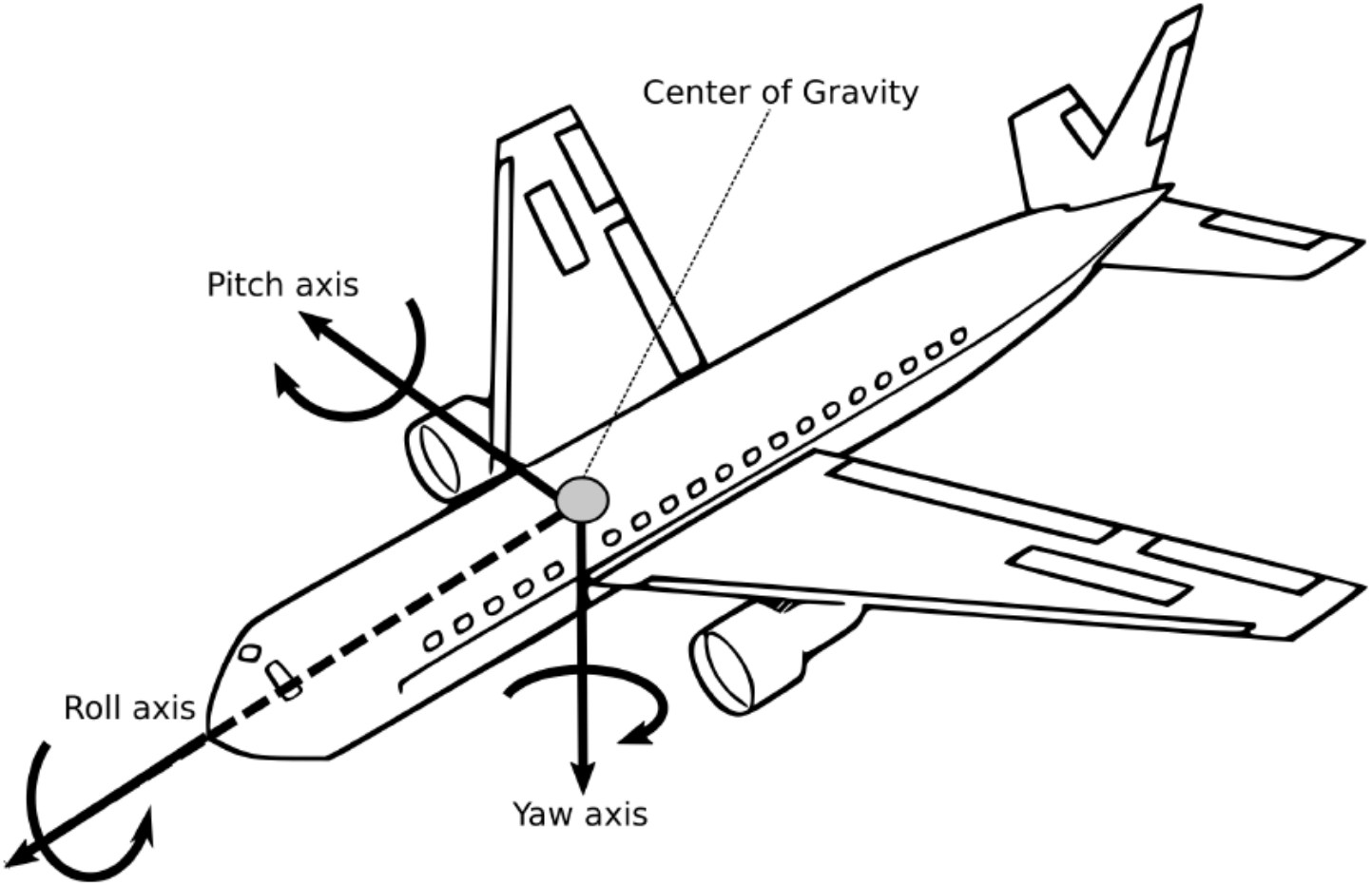
Kinematics and Dynamics

- Kinematics
  - Position and speed (x, x’)
- Dynamics
  - Acceleration and jerk (x’’, x’’’)

Static and Dynamic Stability



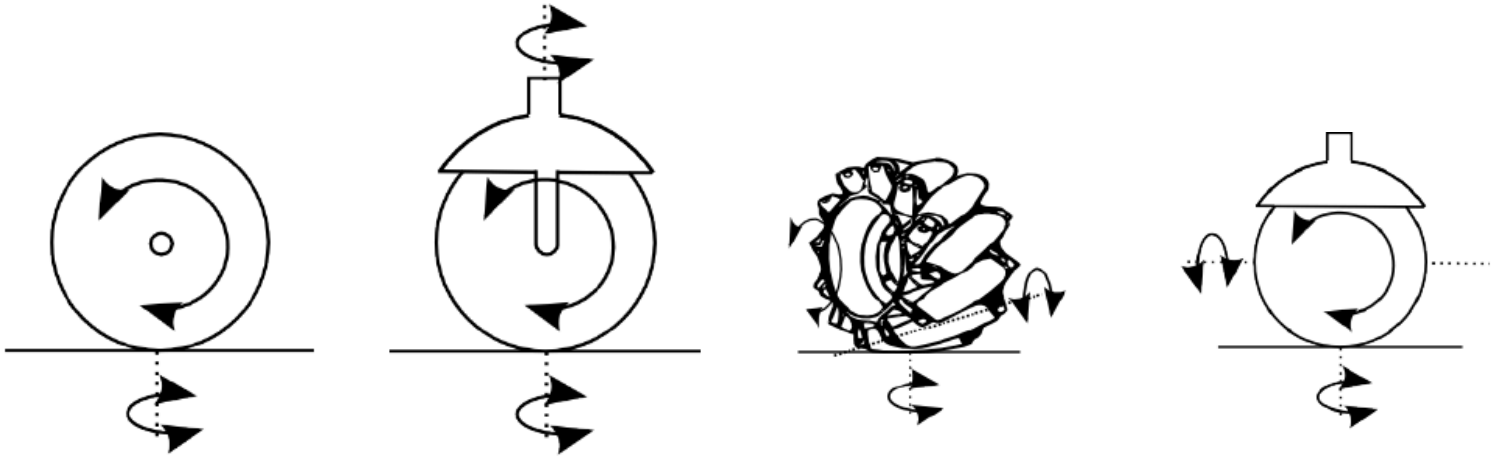
Degrees of Freedom: Pitch, Yaw, and Roll



Brainstorming

- How many degrees of freedom does a car have?

Standard Wheels

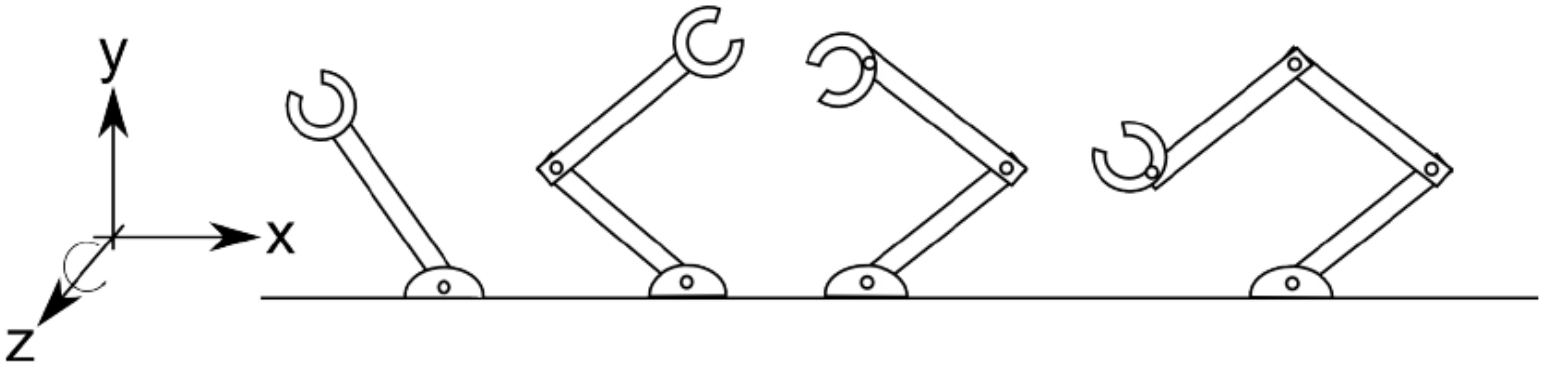


Standard Wheel

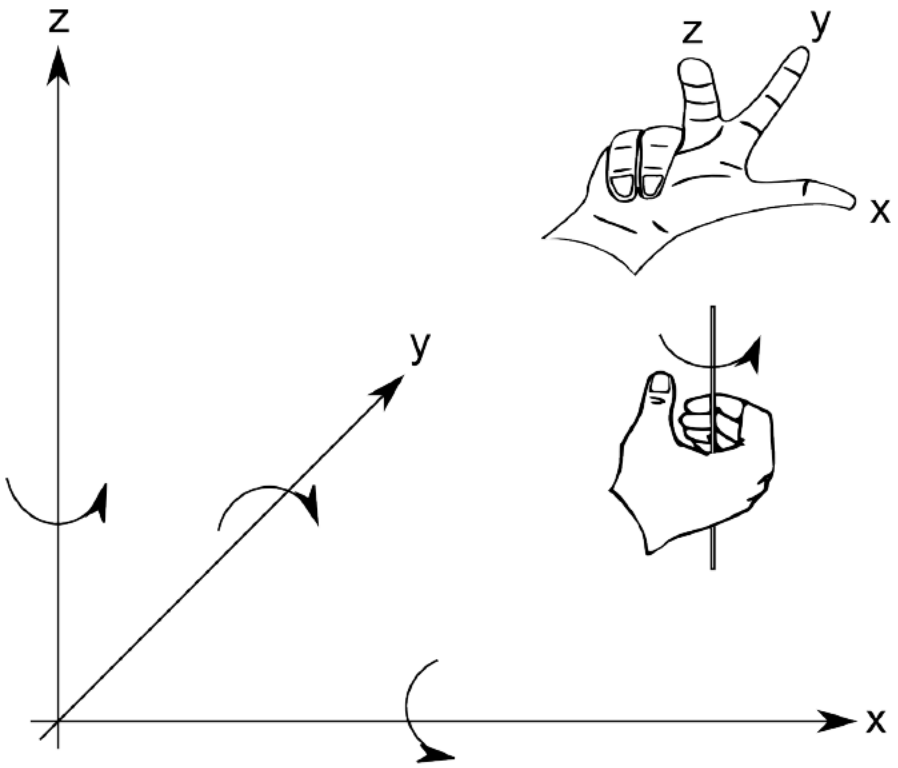
Caster wheel

Swedish wheel

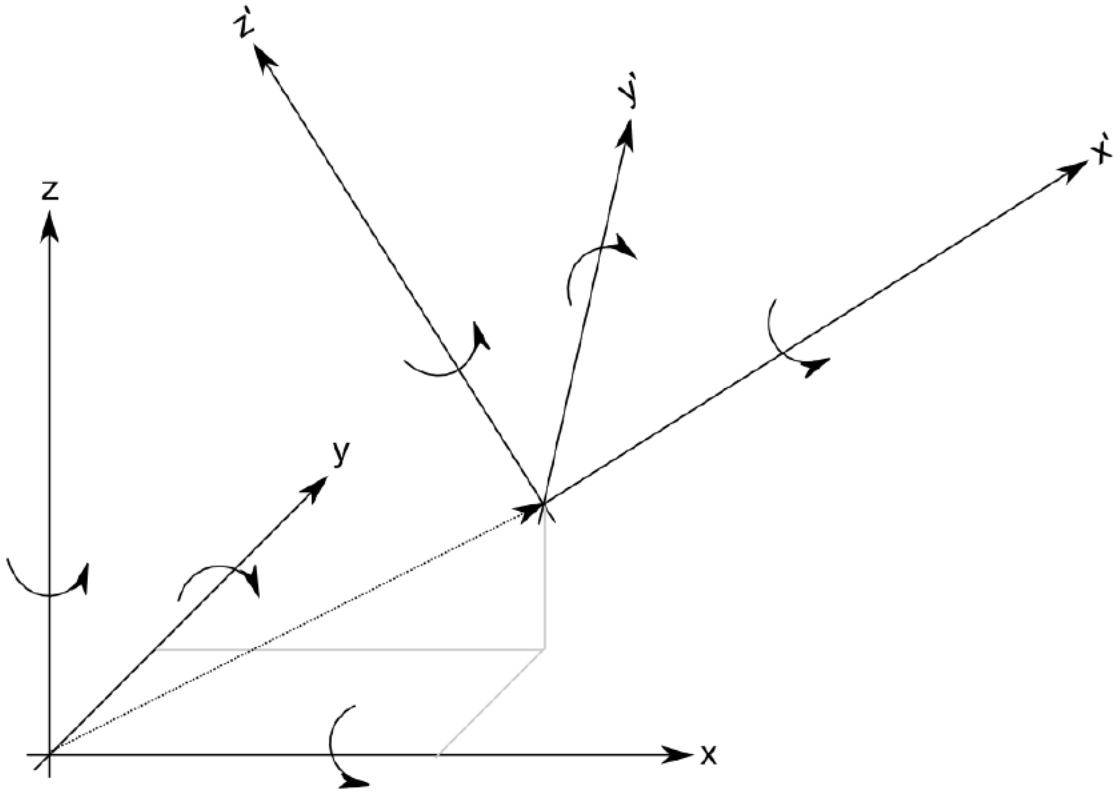
Manipulators



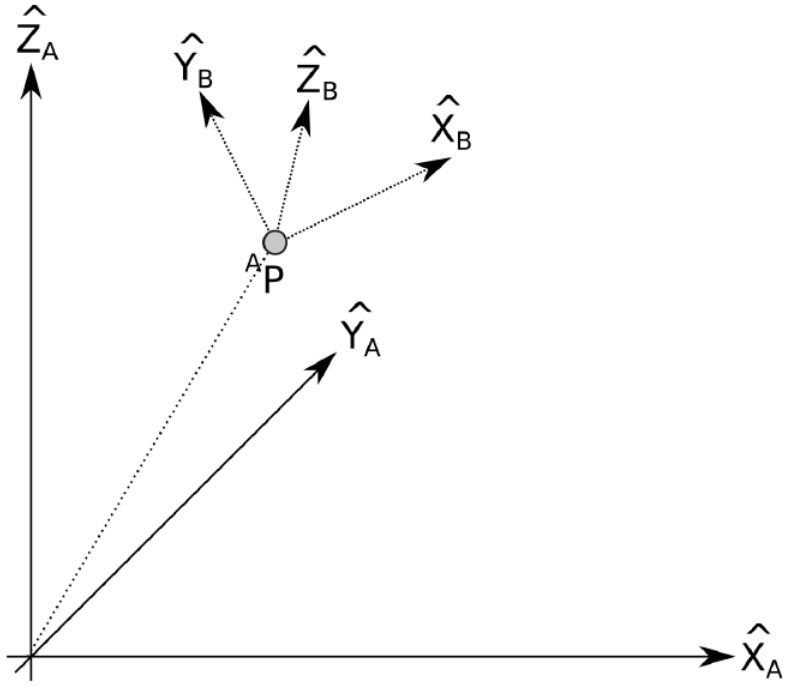
Coordinate System

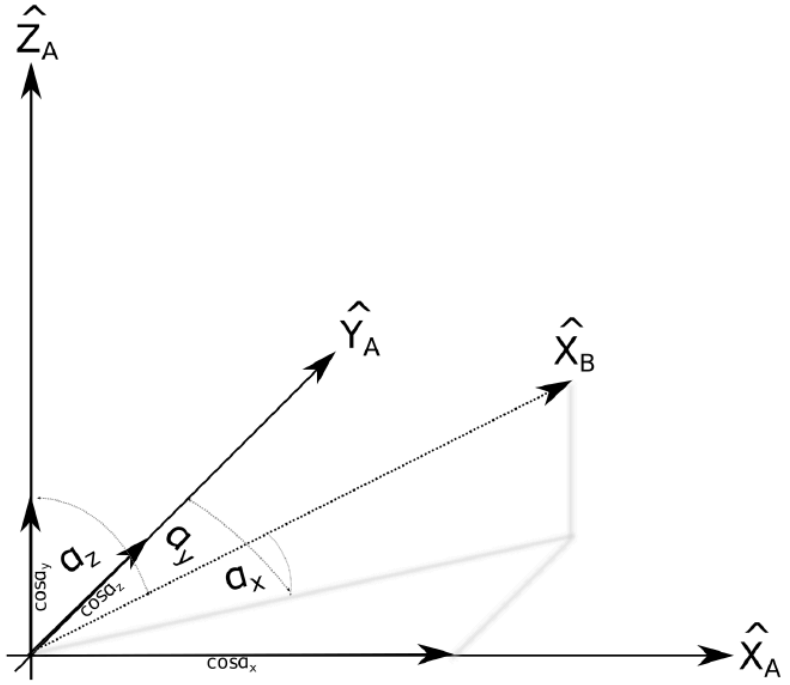


Nested Coordinate Systems



Expressing rotations





Take-home lessons

- Planning / AI requires mapping the robot's actuators into motion in the physical world
- The relationship between position and orientation of the actuators together with the robot's geometry define the forward kinematics
- Many problems in robotics cannot be understood by looking at kinematics alone, this class focusses on slow enough robots.

Outlook

- Homework covers this and next week (available now)
- Lab: reactive behaviors / robot programming basics
- Next week: Forward kinematics