MTR08114 Robotics Overview

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Teaching Team

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  - http://www.ii.ist.i.kyoto-u.ac.jp/~yasser/courses/MTR08114/
- Google Group:
  - *May be*

Text Books

Main Text

- Robot Modeling and Control
  - 1st edition by Mark W. Spong, Seth Hutchinson, and M. Vidyasagar

Other References

- Autonomous Robots Modeling, Path Planning, and Control
  - Farbod Fahimi

- Handbook of Robotics
  - 1st edition by Bruno Siciliano, Oussama Khatib

Course Syllabus

- Basics of Robotics
- Homogeneous Transformations
- Kinematics
- Inverse Kinematics
- Motion Trajectories
- Dynamics
- Control
- Static Forces
- Compliance and Programming
- Algorithms for planning and control
- Position, speed and force control
- Applications

Course Schedule (Tentative)

Lecture	Source	Time
1. Overview	Ch. 1	25/2
2. Homogeneous Transformation	Ch. 2	04/3
3. Rotation Representations	Ch. 2	11/3
4. Kinematics and DH Parameters	Ch. 3	18/3
5. Using DH Parameters with real robots	Ch. 3	25/3
6. Instantaneous Kinematics	Ch. 4	01/4
7. Jacobian	Ch. 4	08/4
8. Kinematics Singularities	Ch. 4	15/4
9. Trajectory Generation	Ch. 5	22/4
10. Independent Joint Control	Ch. 6	29/4
11. Force Control	Ch. 8	06/5
12. Intelligent Control	TBD	13/5

Grading

- Final Exam
- Term Work
  - Midterm Exam
  - Section Work

- No grades are given for attendance

- Department Rules for minimum attendance will be followed STRICTLY

Learning Objectives

- Proficiency in Rigid body motion analysis
- Modeling and analysis of robotic manipulators (serial chain of rigid bodies connected by actuated joints)
- Controller design for motion and force control of robotic manipulators
- Strengths/weakness and performance limitations of current robots

Why Learn Robotics

- Robots are every where
  - PAST: Factories
  - NOW: Offices, Hospitals, and Field
  - FUTURE: Home
- Apply your knowledge of mechanics
- Have Fun!!!

Where does Robotics Fit

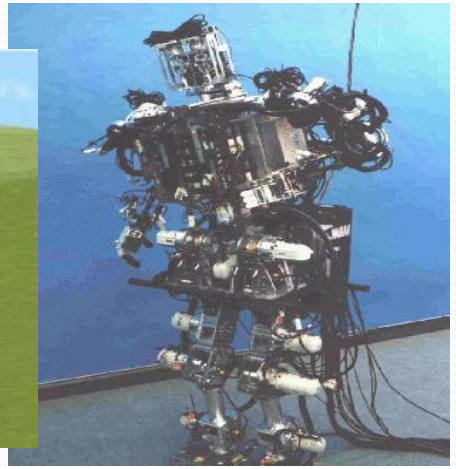
- Mechanical Engineering
- Mathematics
- Electrical Engineering
- Computer Engineering
- Machine Learning/AI
- Social Sciences/Psychology

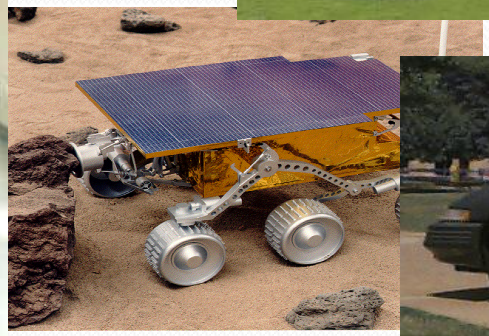
This course focuses on the mechanical/mathematical aspects

What is a Robot anyway

- Appeared in 1920 play *Rossum's Universal Robots* by Karel Capek
- Comes from the Czech word *Robota* meaning work





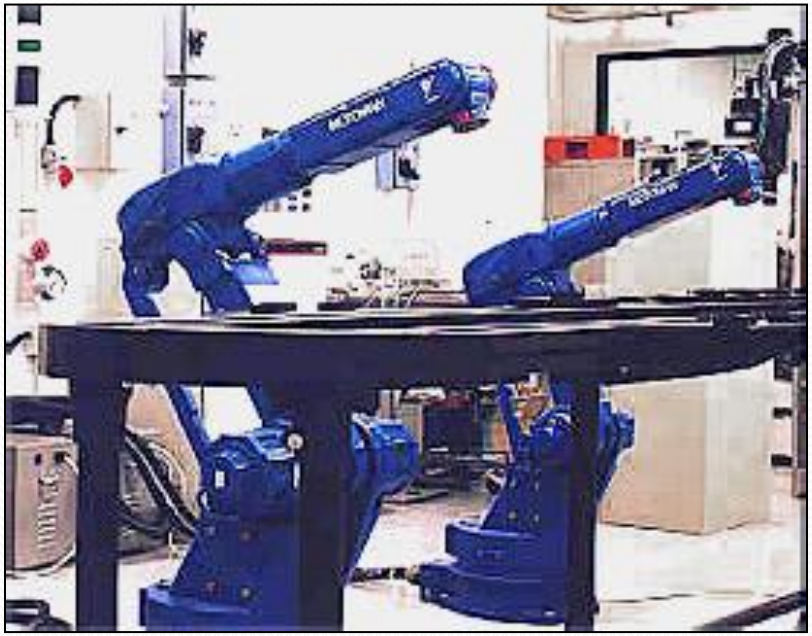

Definition

- Book: Computer Controlled Industrial Manipulator

- RIA: a reprogrammable multifunctional manipulator designed to move material, parts, tools, or specialized devices through variable programmed motions for the performance of a variety of tasks.

Types of Robots

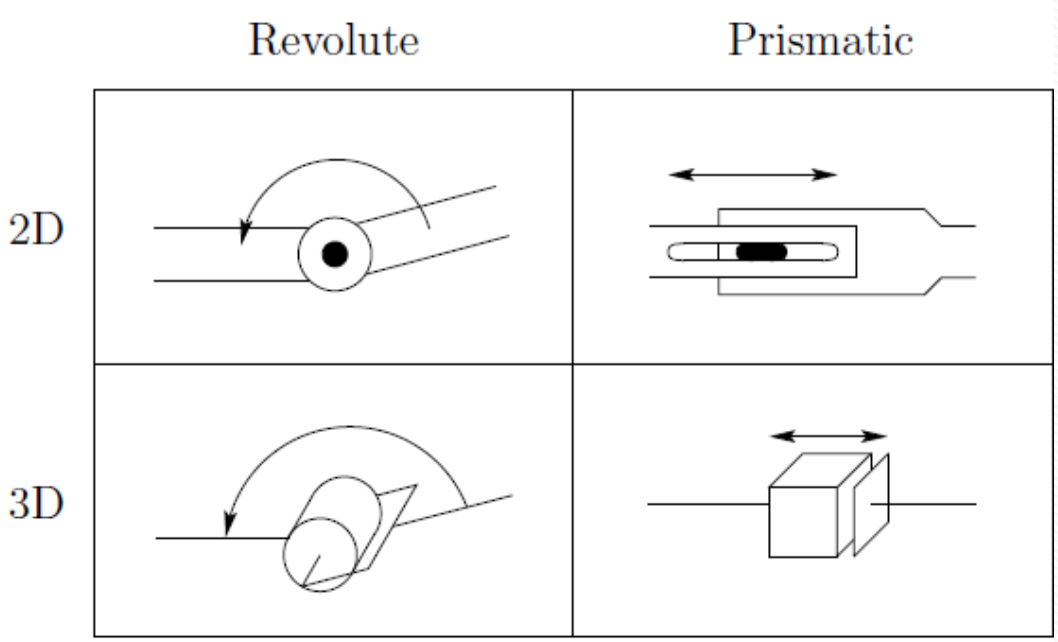
- Industrial Robots



- Service Robots

Symbolic Representation

- Kinematic Chains = links+Joints



- Joint Angle (Revolute) = Θ
- Displacement (Prismatic) = d

Definitions

- Configuration
  - Complete specification of the location of every point in the robot
- Configuration Space
  - All possible configurations
- Degrees of freedom (DOFs)
  - Minimum number of numbers to specify a configuration.
  - 3D objects has 6 DOFs
- Kinematic Redundancy
  - Having more than 6 links

Definitions cont.

- State
  - a set of variables that, together with a description of the manipulator's dynamics and input, are sufficient to determine any future state of the manipulator
- State Space
  - All possible states
- Reachable Workspace
  - Total space accessible by the end effector
- Dexterous Workspace
  - The subset of the reachable workspace that is reachable with arbitrary orientation
- DOFs=n → variables in state= 2n (values+velocities)

Robot Classification - Power

- Electric
  - Cheap and controllable
- Hydraulic
  - Heavy lifting
- Pneumatic
  - Difficult to control

Robot Classification - Application

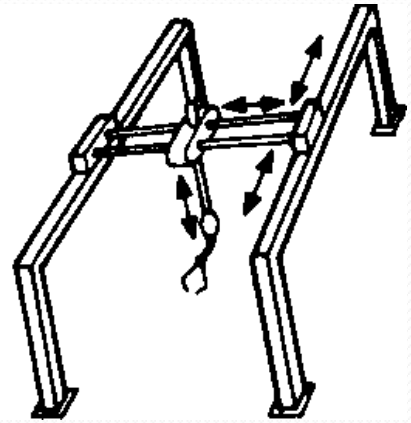
- Assembly
- Non-Assembly

Robot Classification - Control

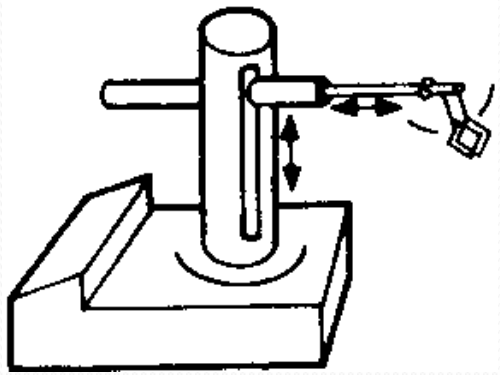
- Non-servo
  - Open loop
- Servo
  - Point-to-point
  - Continuous path

Geometry (Examples)

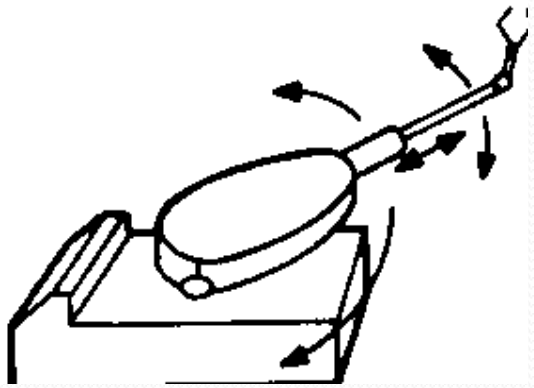
Cartesian



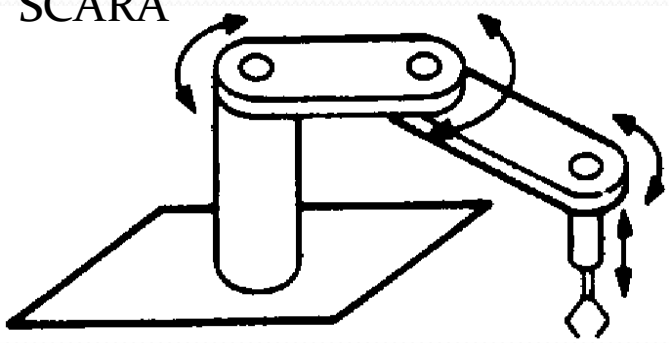
Cylindrical



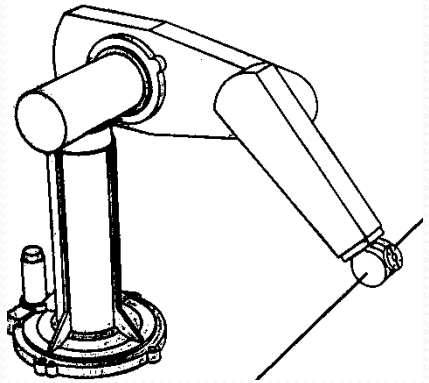
Spherical



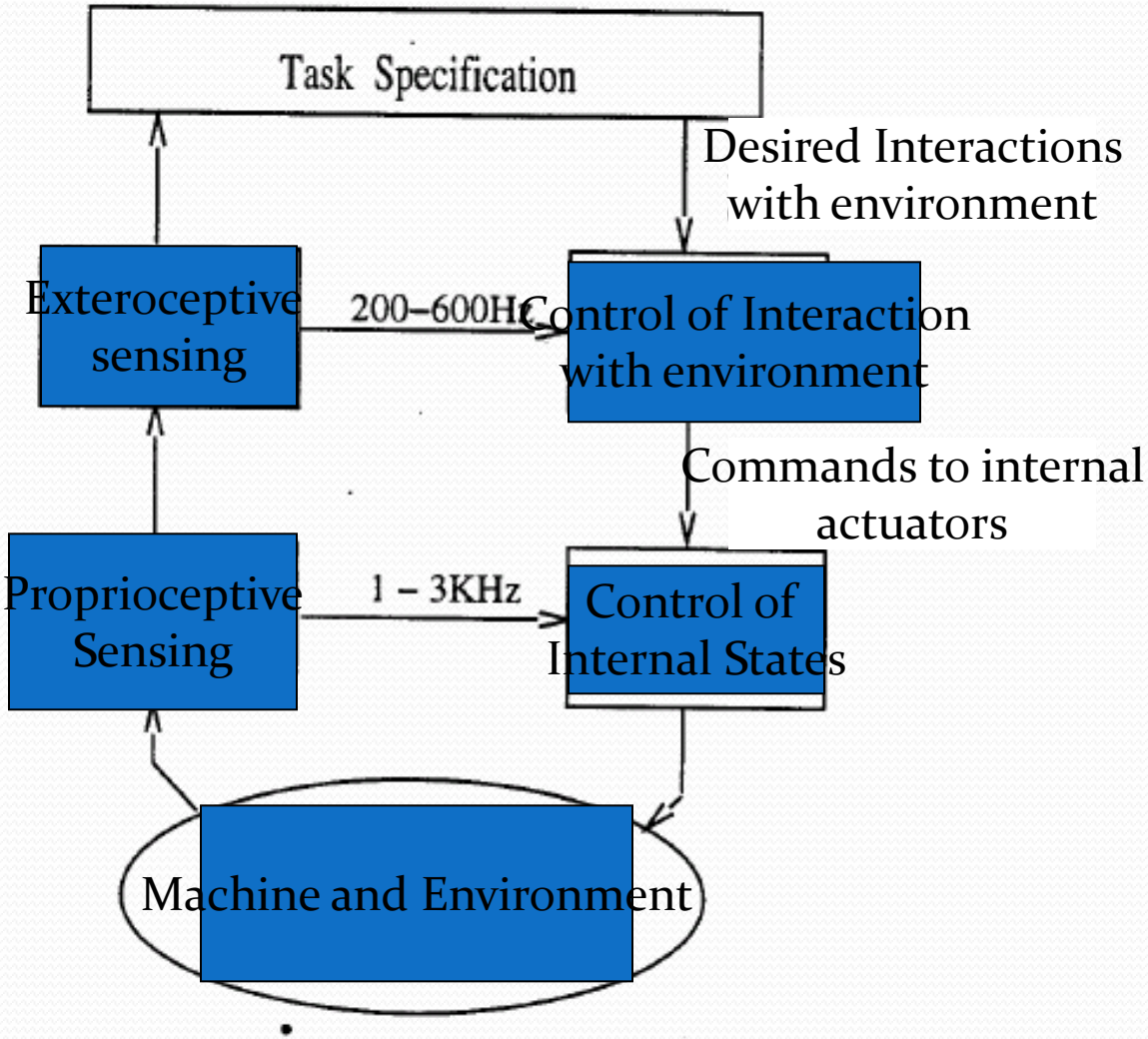
SCARA



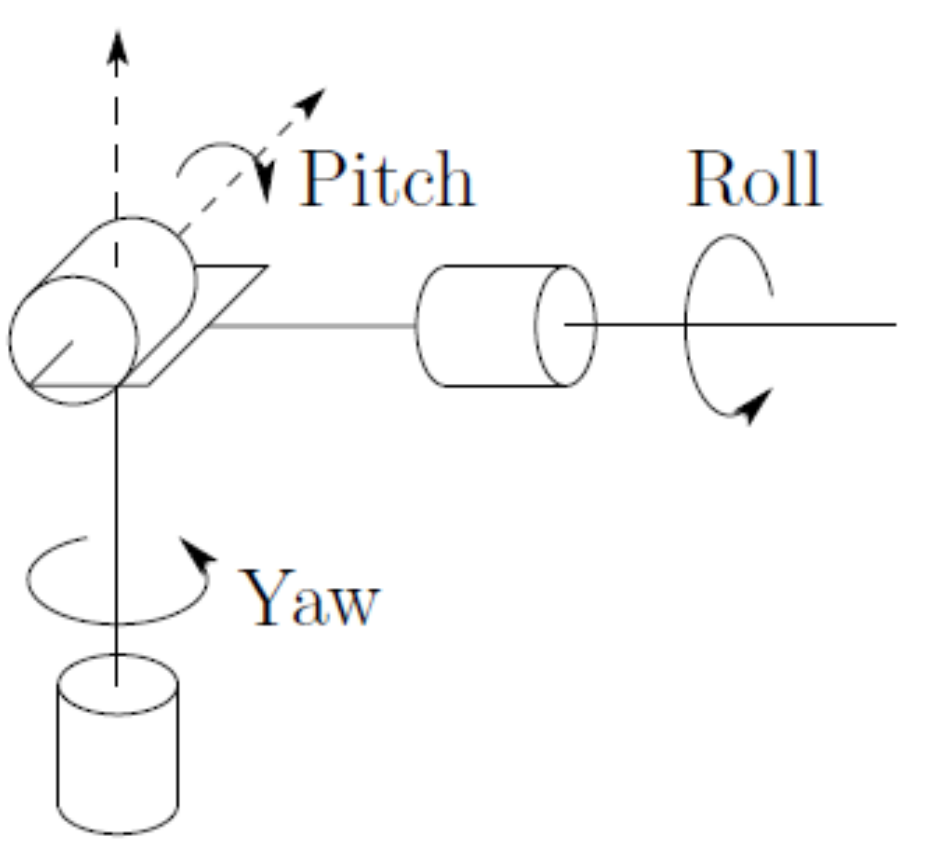
Articulated



General Operation

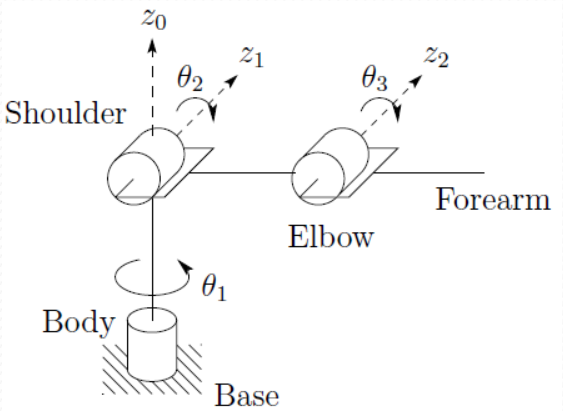


Wrest (Spherical)

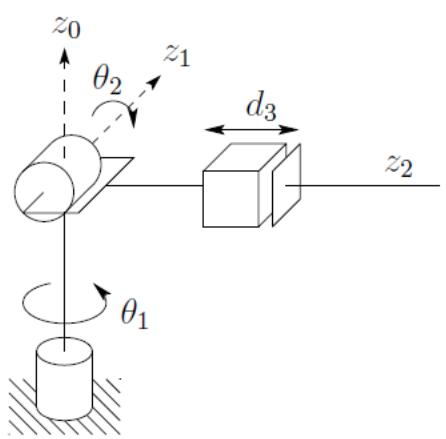


Common Kinematic Arrangements

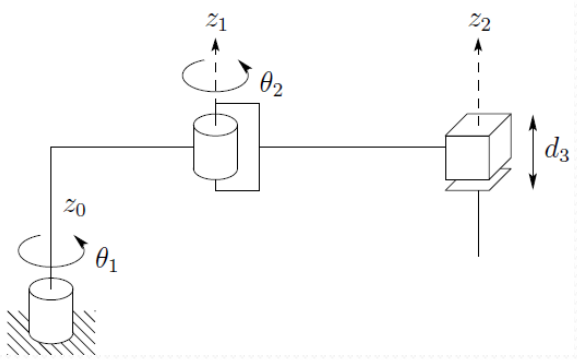
Articulated (RRR)



Spherical (RRP)



SCARA (RRP)



Important Notes

- Not all robots are manipulators
- In this course nearly ALL robots are arms

Video (Mobile Assembly)

Example Human-Robot Interaction

FIRST ASSIGNMENT

- Find a nice robot demonstration from the web.