

Chapter 2 Configuration Space
 2.1 DOF of a Rigid Body
 2.2 DOF of a Robot

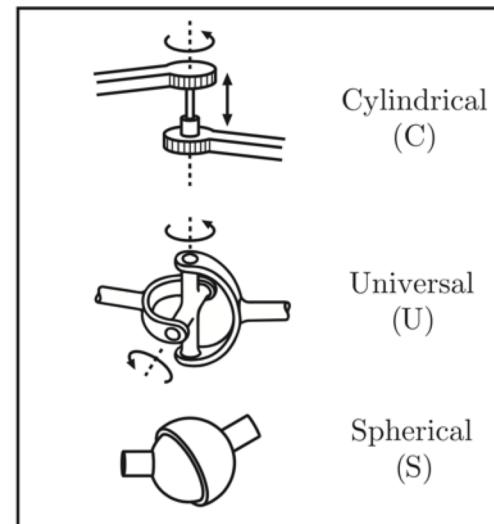
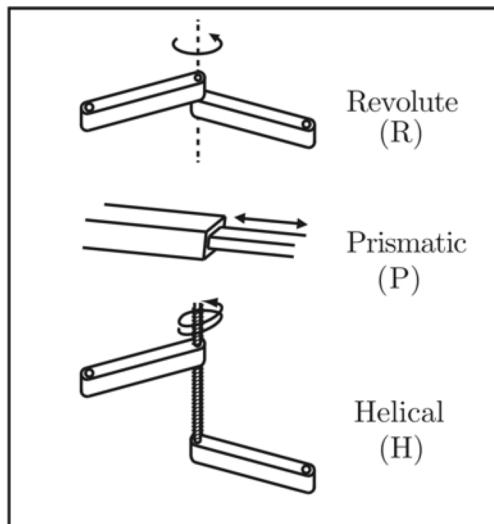
- Chapter 3 Rigid-Body Motions
- Chapter 4 Forward Kinematics
- Chapter 5 Velocity Kinematics and Statics
- Chapter 6 Inverse Kinematics
- Chapter 7 Kinematics of Closed Chains
- Chapter 8 Dynamics of Open Chains
- Chapter 9 Trajectory Generation
- Chapter 10 Motion Planning
- Chapter 11 Robot Control
- Chapter 12 Grasping and Manipulation
- Chapter 13 Wheeled Mobile Robots

Important concepts, symbols, and equations

- **configuration**: a specification of the positions of all points of a mechanism
- **degrees of freedom** (dof): # of real #s required to describe a configuration
- **configuration space** (C-space): the dof-dimension space of all configurations
- dof of a planar body: $m = 3$; dof of a spatial body: $m = 6$

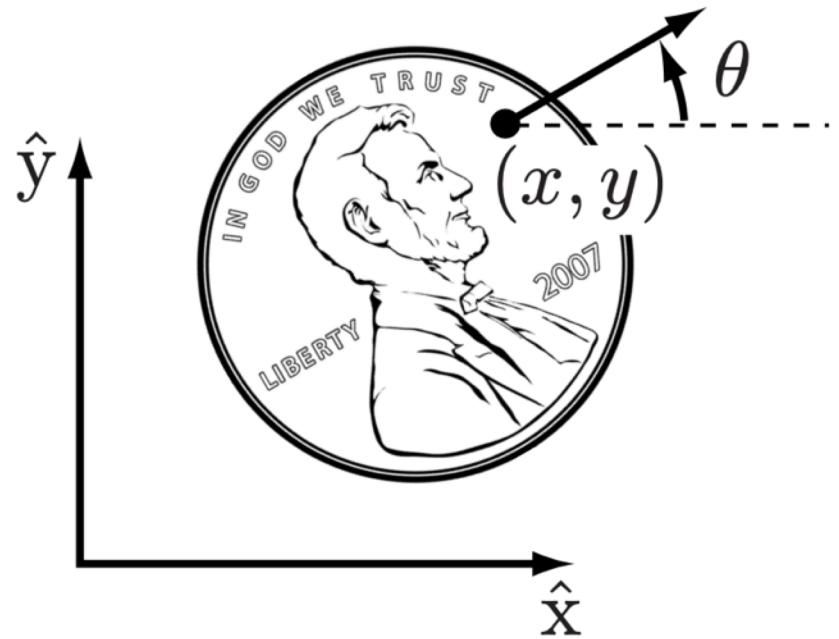
Important concepts, symbols, and equations (cont.)

- mechanism dof = Σ (body freedoms) – Σ (independent constraints from joints)
- joint types:

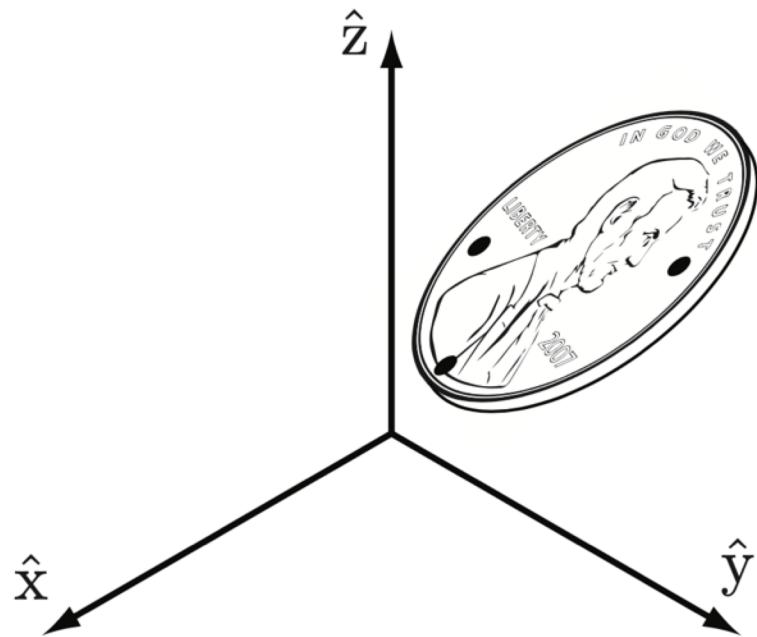


Joint type	dof f	Constraints c between two planar rigid bodies	Constraints c between two spatial rigid bodies
Revolute (R)	1	2	5
Prismatic (P)	1	2	5
Helical (H)	1	N/A	5
Cylindrical (C)	2	N/A	4
Universal (U)	2	N/A	4
Spherical (S)	3	N/A	3

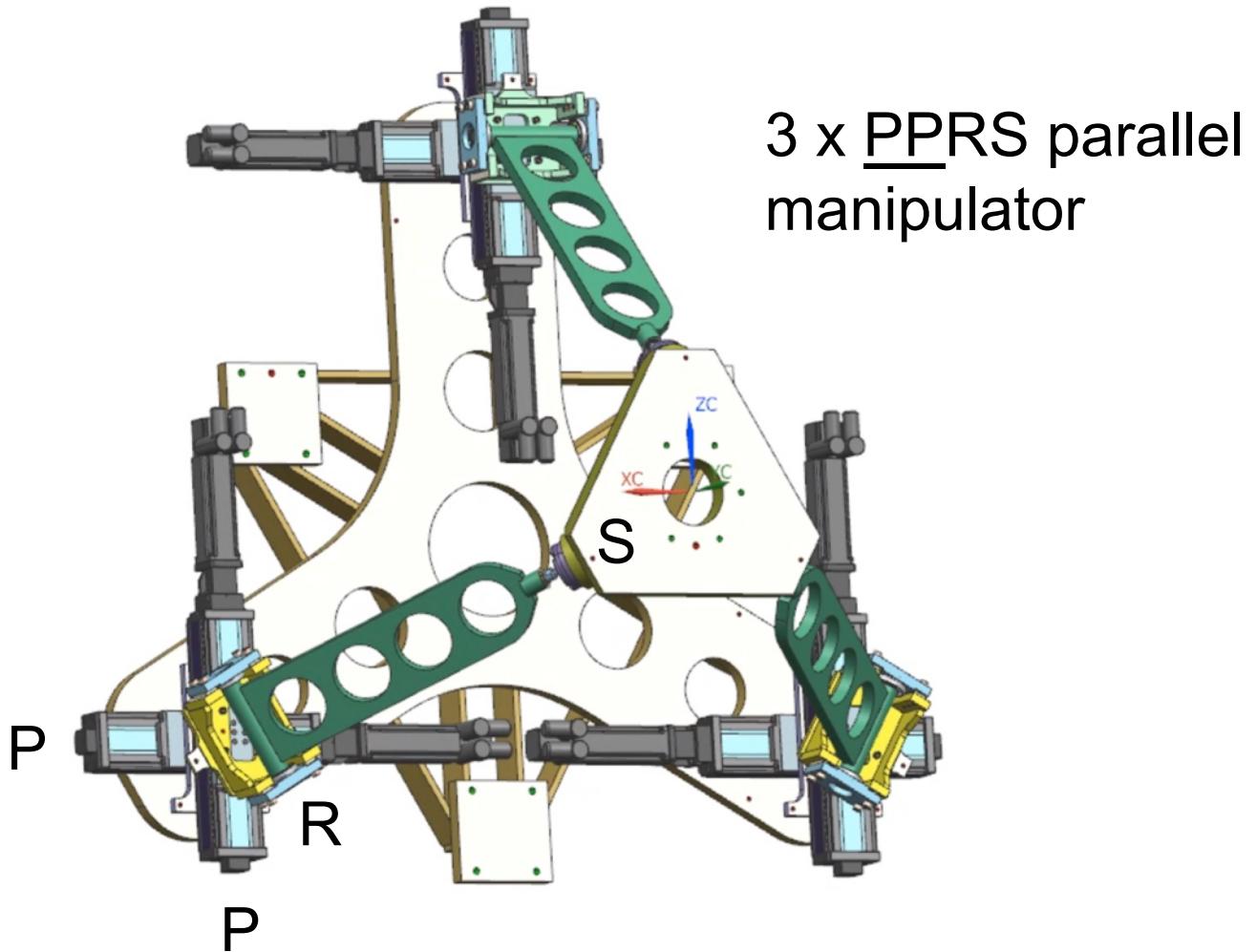
- Grübler's formula:** $\text{dof} = m(N - 1 - J) + \sum_{i=1}^J f_i$



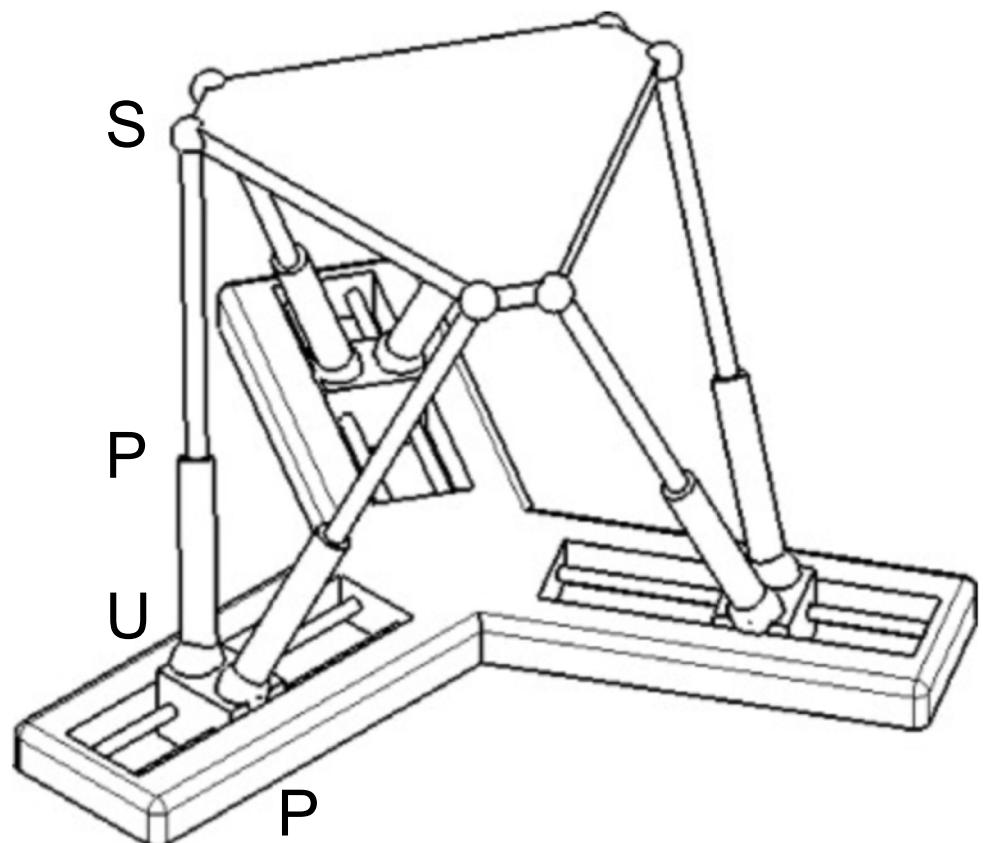
coin on a plane



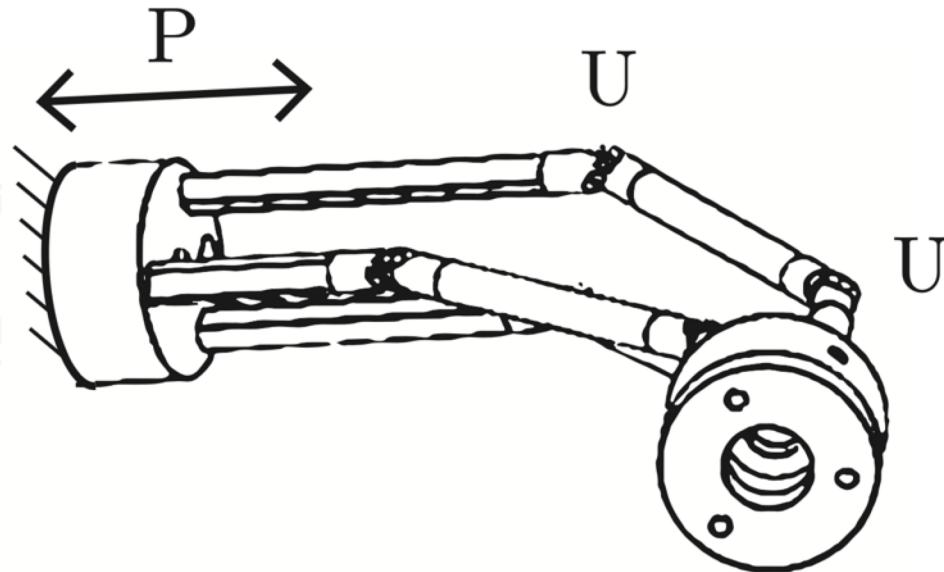
coin in space



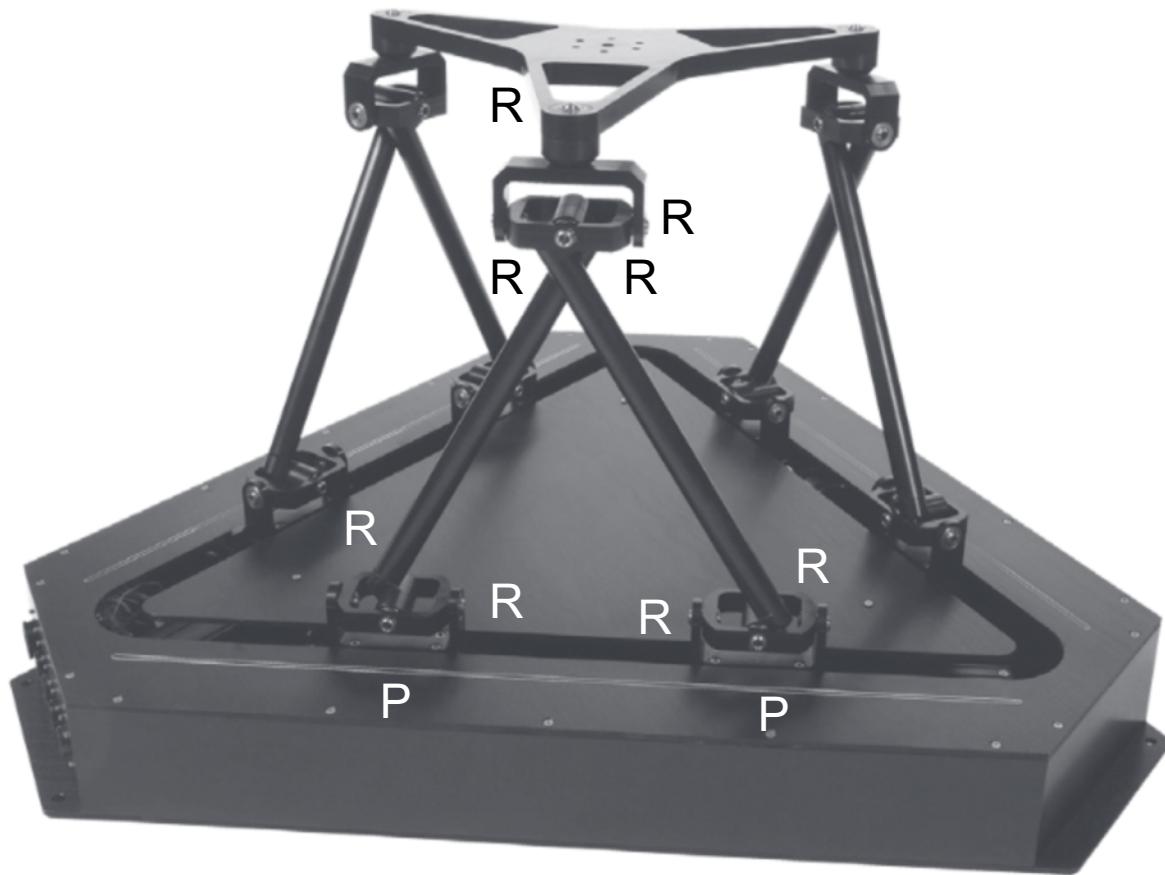
KUKA Systems North America LLC
(patent pending)



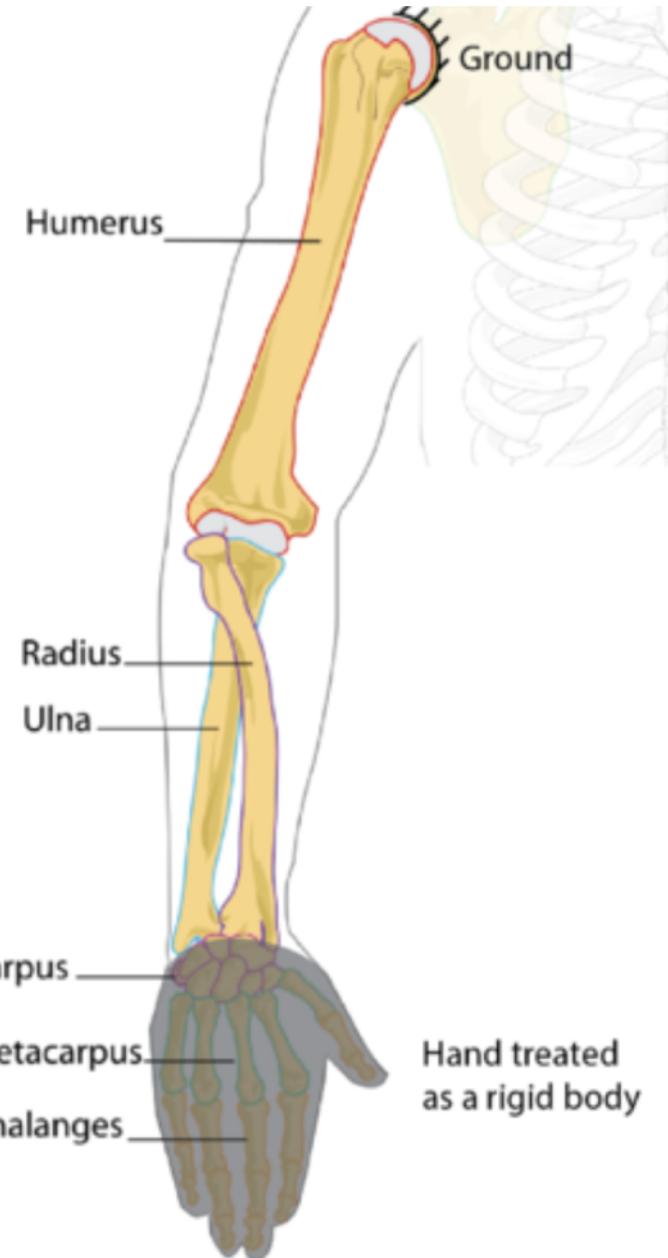
$3 \times \underline{\text{P}}\text{UU}$ miniature surgical parallel manipulator
(National University of Singapore)



Quanser Hexapod



<https://www.youtube.com/watch?v=AyVu4AE25DM>



How many dof does the human arm have?

Method 1: add dof of joints (shoulder, elbow, wrist)

Method 2: fully constrain hand's position

How many total constraints are imposed by the joints?