Where we are:

Chap 2 Configuration Space

- 2.1 DOF of a Rigid Body
- 2.2 DOF of a Robot

Chap 3 Rigid-Body Motions
Chap 4 Forward Kinematics
Chap 5 Velocity Kinematics and Statics
Chap 6 Inverse Kinematics
Chap 8 Dynamics of Open Chains
Chap 9 Trajectory Generation
Chap 11 Robot Control
Chap 13 Wheeled Mobile Robots

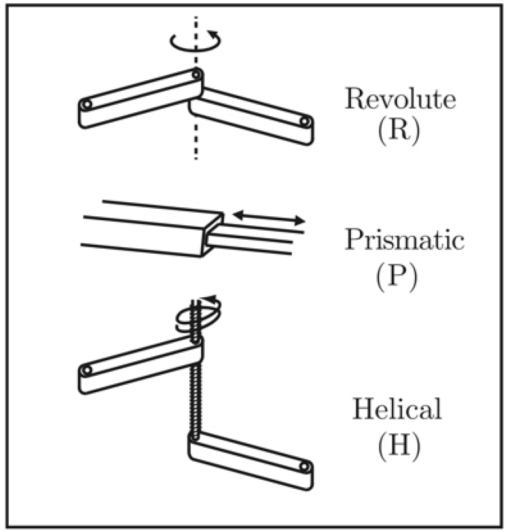
Important concepts, symbols, and equations

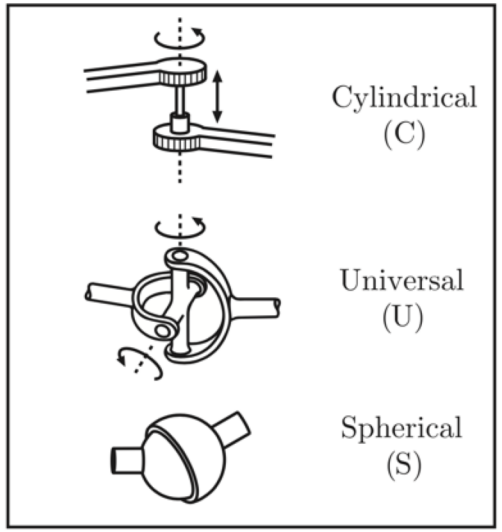
- **configuration**: a specification of the positions of all points of a mechanism
- **degrees of freedom** (dof): # of real #s required to describe a configuration
- **configuration space** (C-space): the dof-dimension space of all configurations
- dof of a planar body: $m = 3$; dof of a spatial body: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

Important concepts, symbols, and equations (cont.)

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

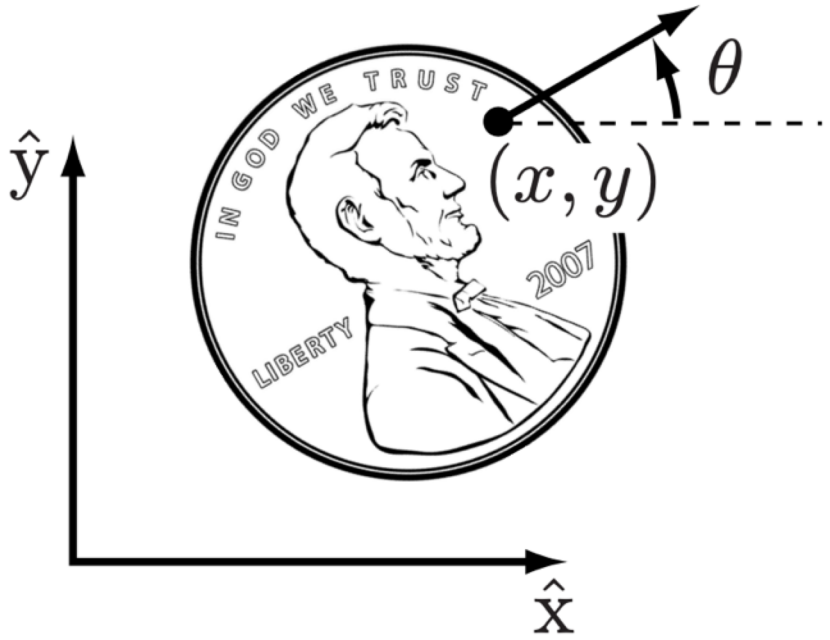
- joint types:



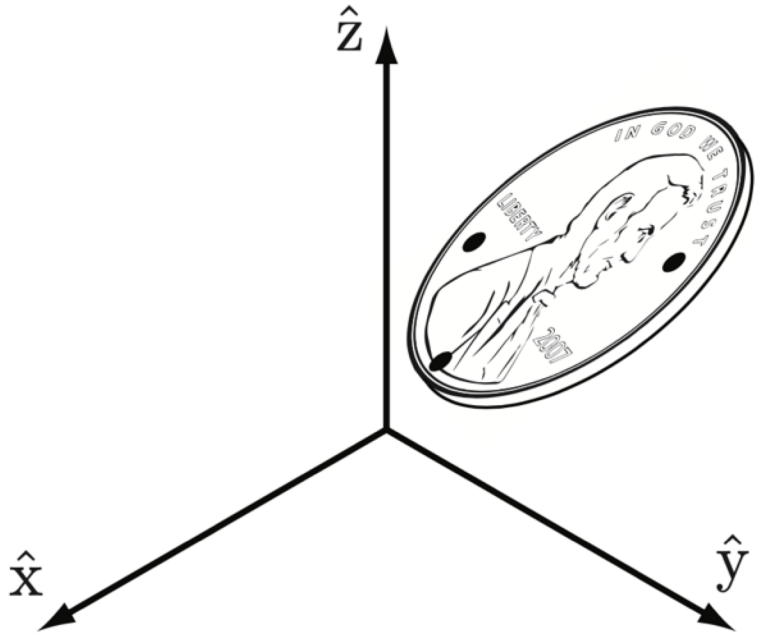


Joint type	dof f	Constraints c between two planar rigid bodies	Constraints c between two spatial rigid bodies
Revolute (R)	1	2	5
Prismatic (P)	1	2	5
Helical (H)	1	N/A	5
Cylindrical (C)	2	N/A	4
Universal (U)	2	N/A	4
Spherical (S)	3	N/A	3

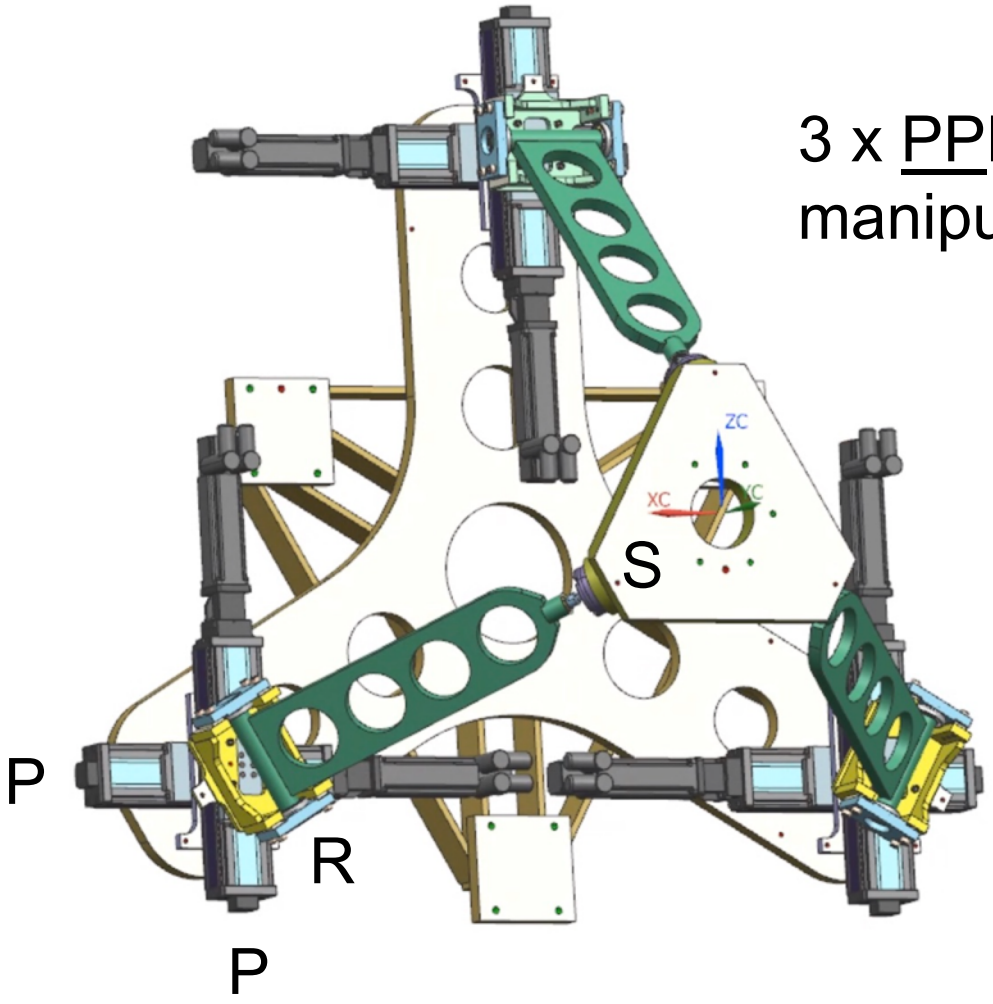
- **Grübler's formula**: $\text{dof} = m(N-1-J) + \sum_{i=1}^{J} f_i$



coin on a plane

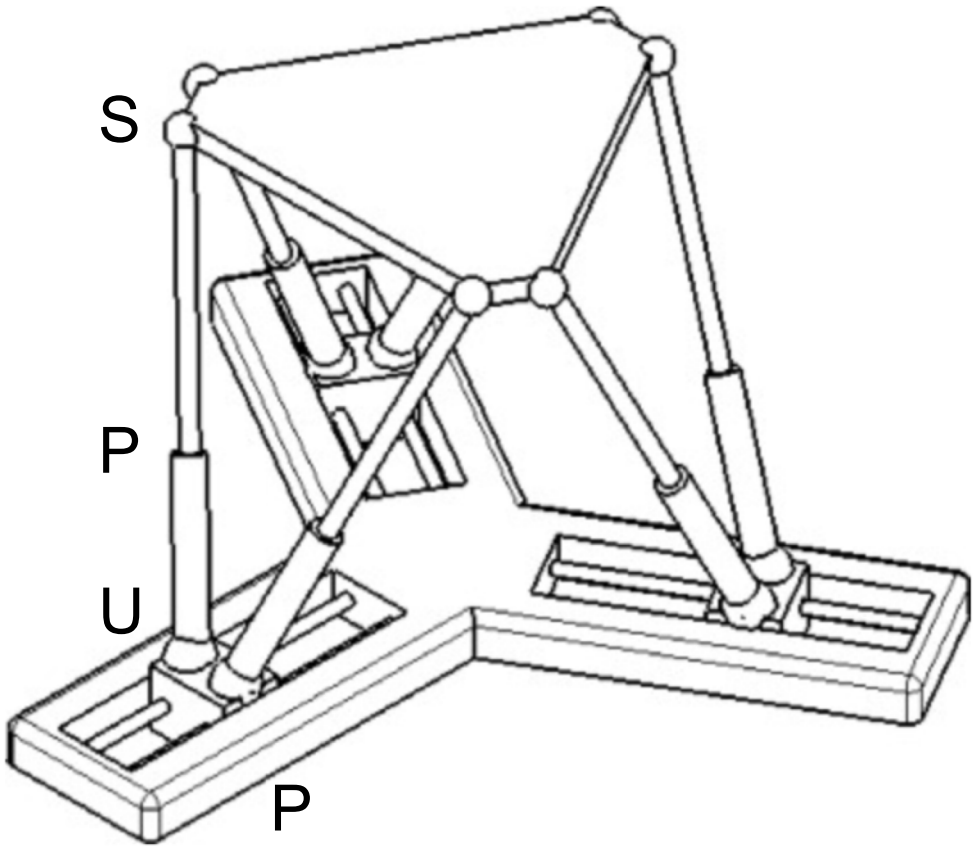


coin in space

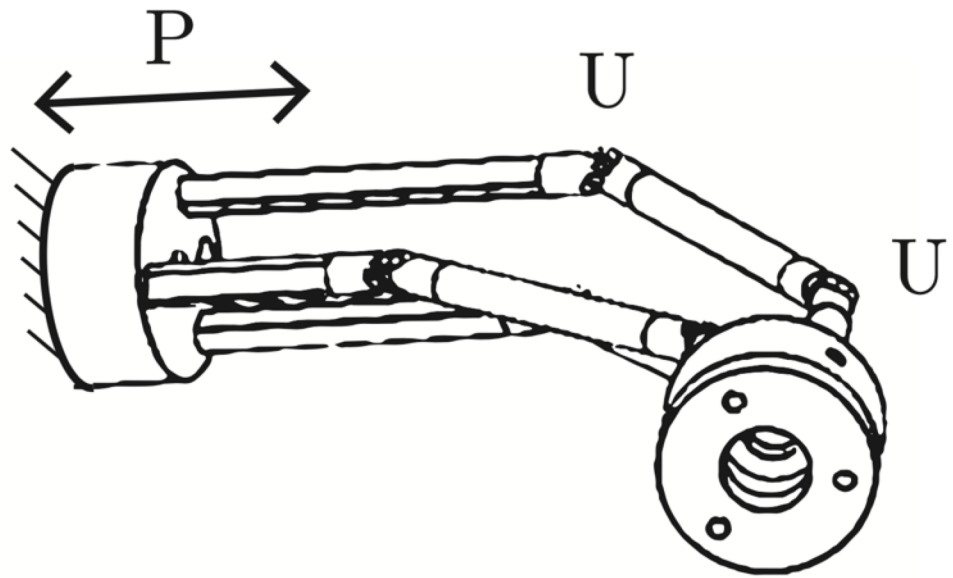


3 x PPRS parallel manipulator

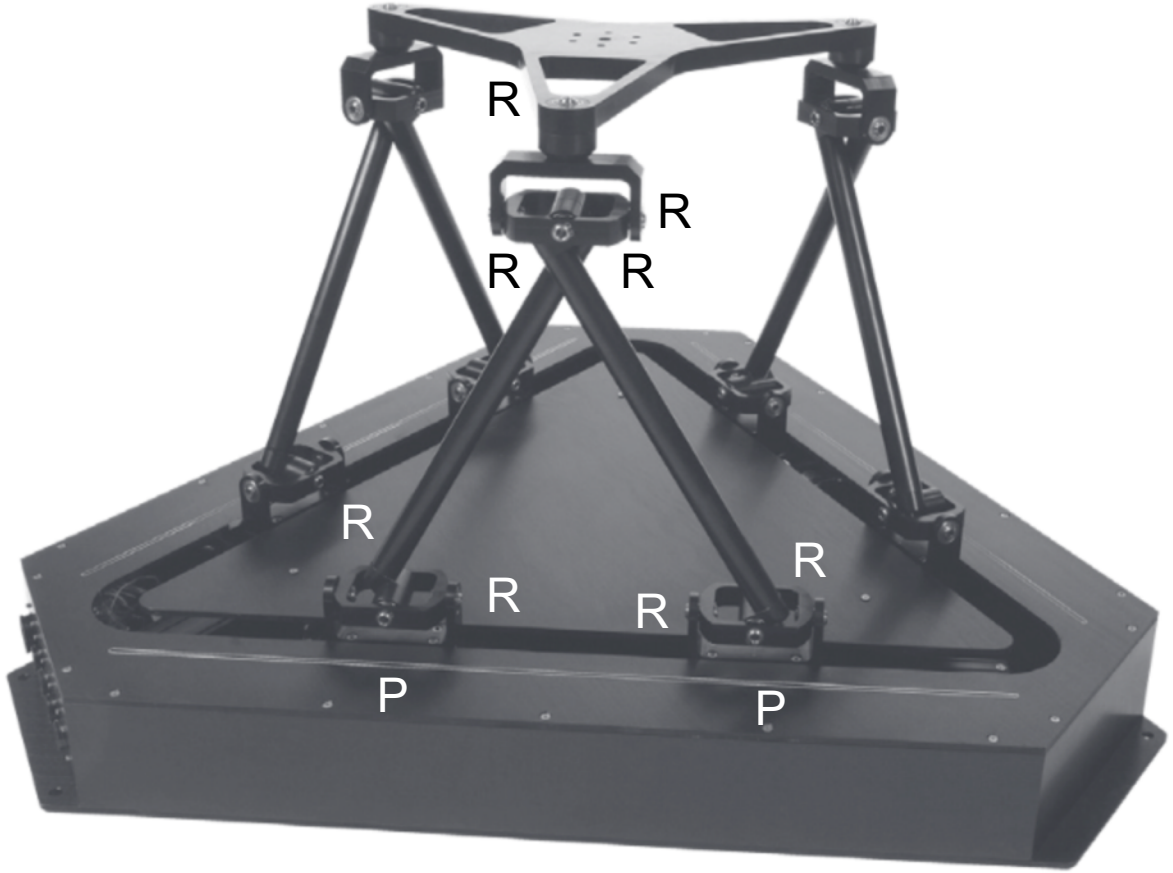
KUKA Systems North America LLC
(patent pending)


S
P
U
P

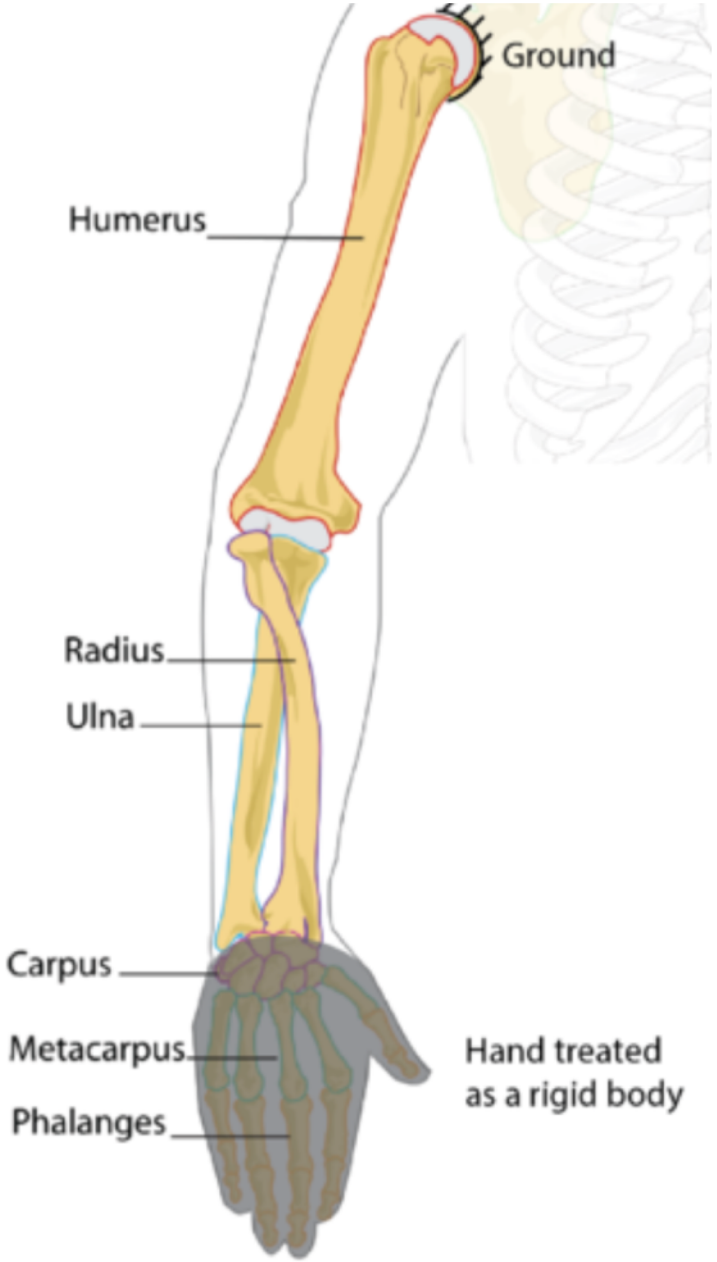
3 x PUU miniature surgical parallel manipulator
(National University of Singapore)



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?