Basics of Practical Grasping

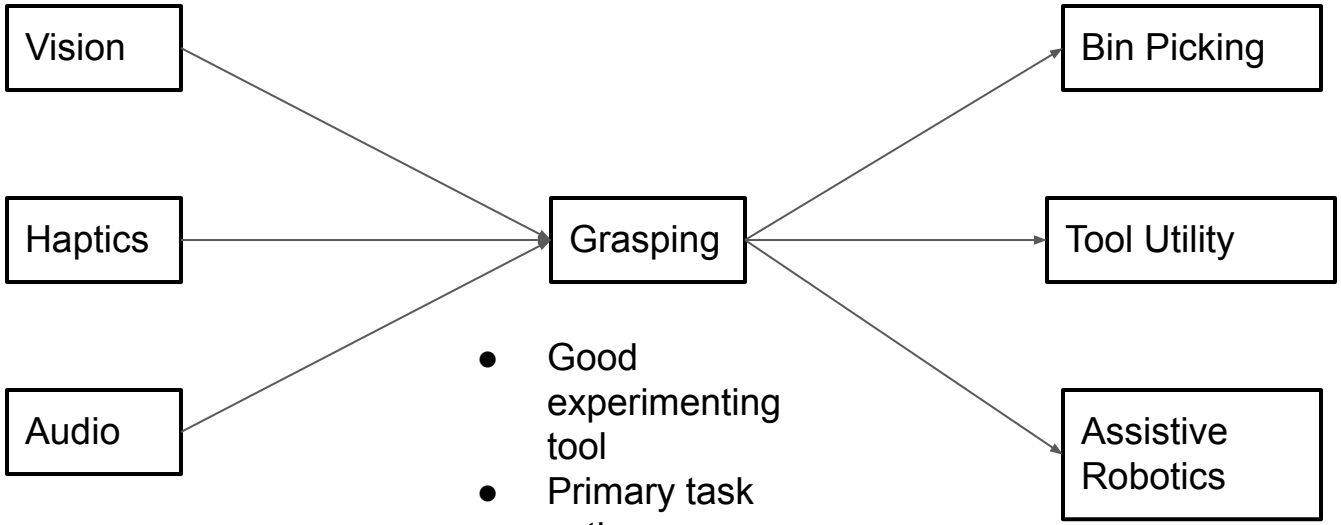
Shubhan P. Patni, Lukas Rustler, Matej Hoffmann

Humanoids and Cognitive Robotics Lab
Department of Cybernetics, FEE, CTU

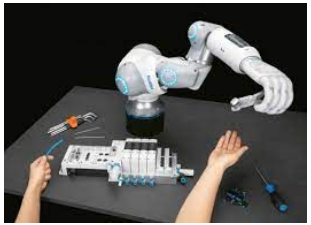
Why Grasping?

Object Exploration

Object Manipulation



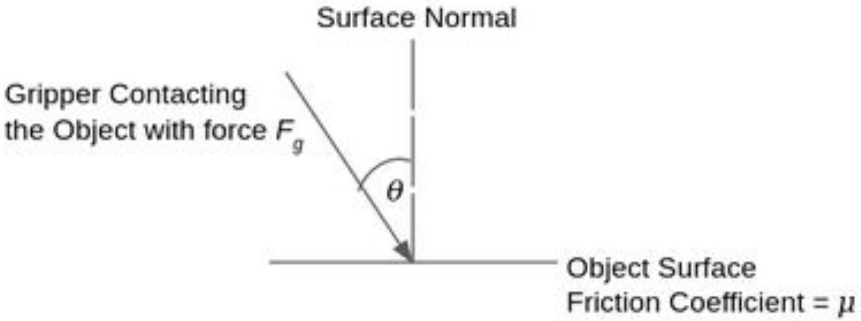
- Good experimenting tool
- Primary task action



Friction Cones

Do it Yourself!

Simplest case: Just one contact force



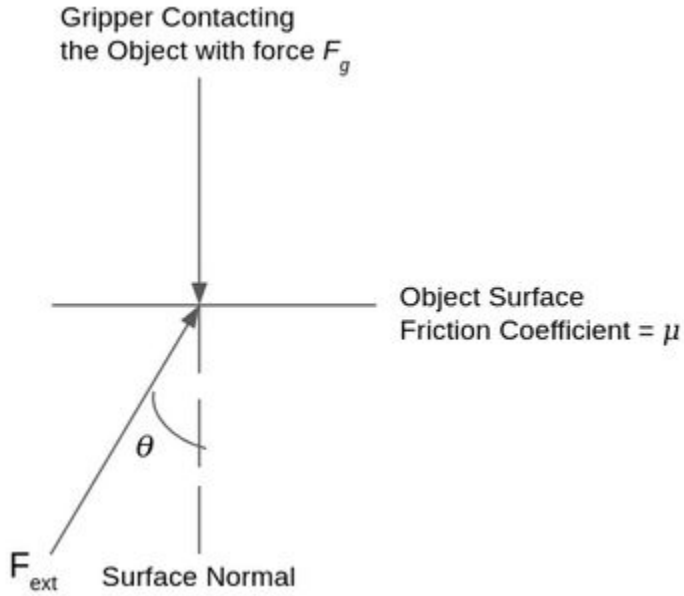
$$\mu F_g \cos\theta \geq F_g \sin\theta$$

$$\theta = \tan^{-1} \mu$$

- In this case, the cone width does not depend on the value of force!!

Interaction at each Contact Point

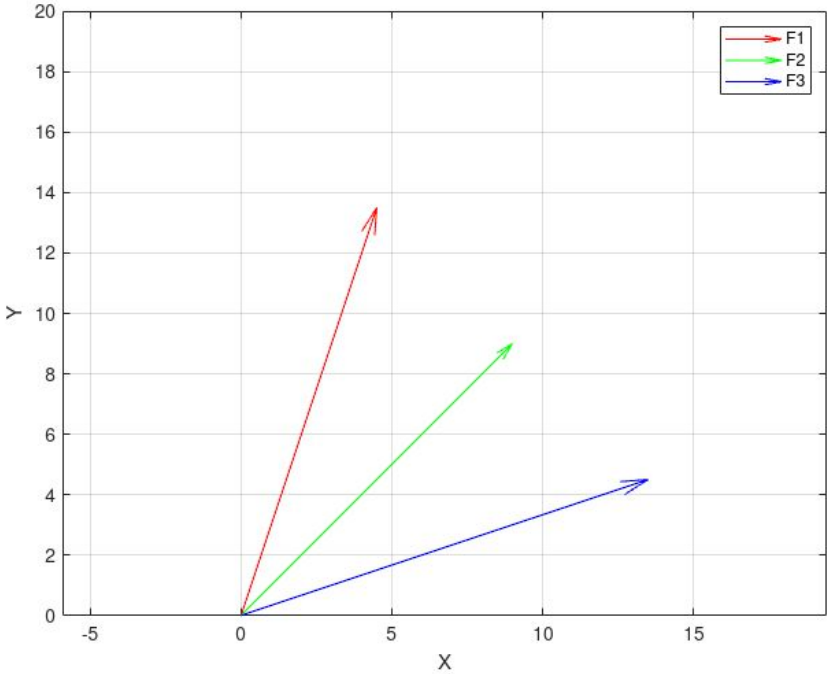
Adding external forces that may disturb equilibrium



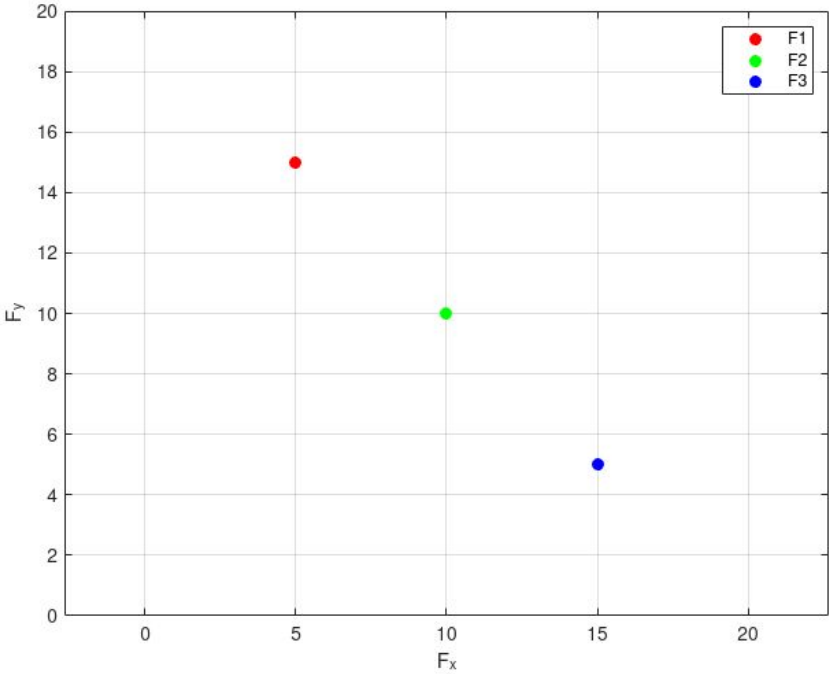
$$\mu F_g \geq \mu \underbrace{F_{ext}\cos\theta}_{F_y} + \underbrace{F_{ext}\sin\theta}_{F_x}$$

Grasping Spaces

Cartesian Space

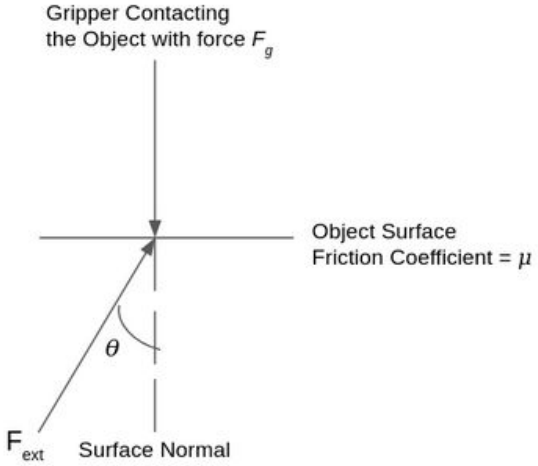


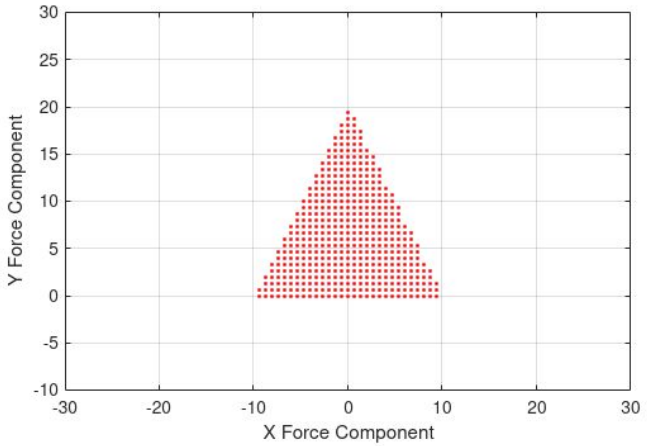
Grasping Space



Wrench Space

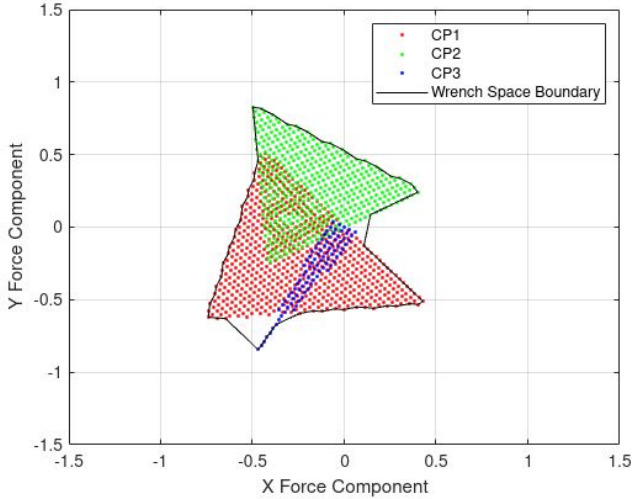
- Set of forces that the gripper can resist.
- Plotted in Grasp Space coordinates
- Dependent on the gripper force as well as the surface friction

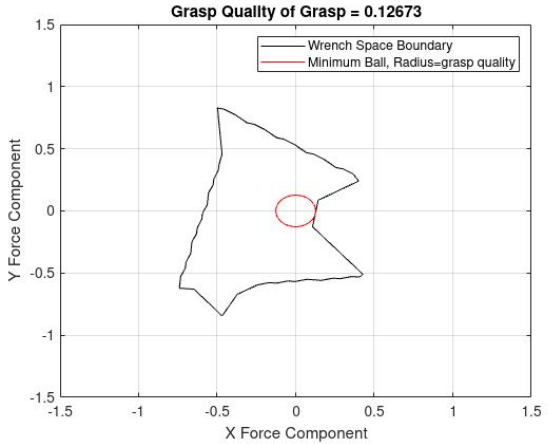




Computing Grasp Quality

- Multiple Contact points oriented on the object.
- The individual spaces are combined with a polygonal boundary.
- Radius of the largest circle which fits within this polygon with the origin as its centre





Complexity of Grasping

- In reality - 3D objects, 6D grasp spaces, difficult to obtain equations, visualize
- Object shapes add constraints to possible grasp configurations
- Deformable objects cannot be modeled as point contacts

Thank You!
Any Questions?