Geometrical Constraint in Grasping

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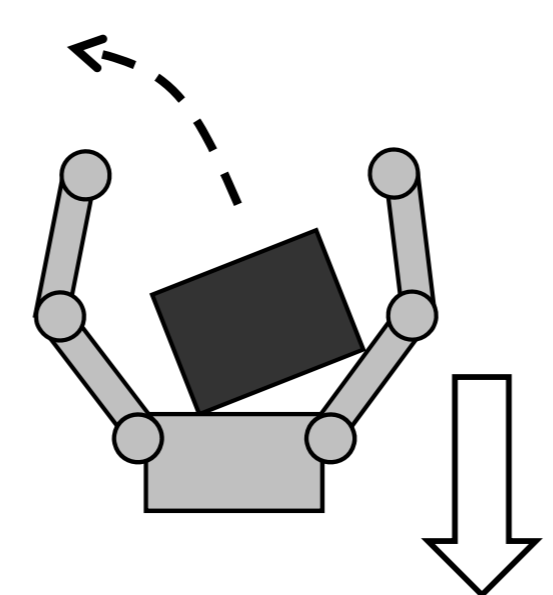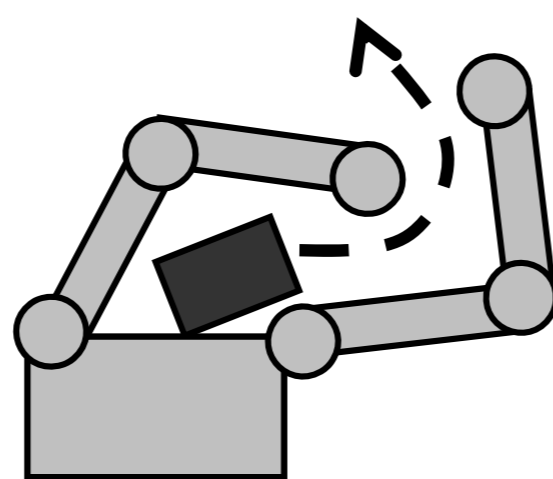http://www.sasebo.ac.jp/~makita/

Geometrical Constraint (Caging) in Grasping

- Force sensing and control is not always necessary
    - -> position control can be used for grasping
- Use as another index of reliable grasping
    - -> fail-safe strategies can be considered
- Indeterminacy of contact points between the objects and the robots
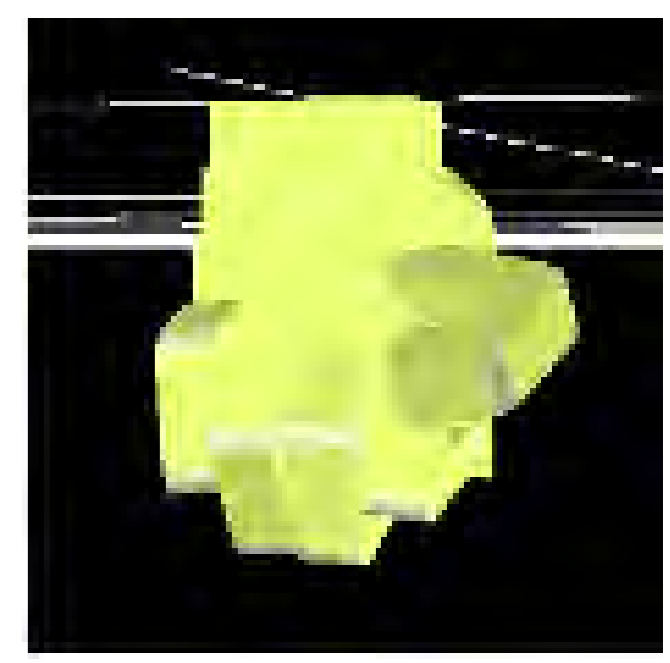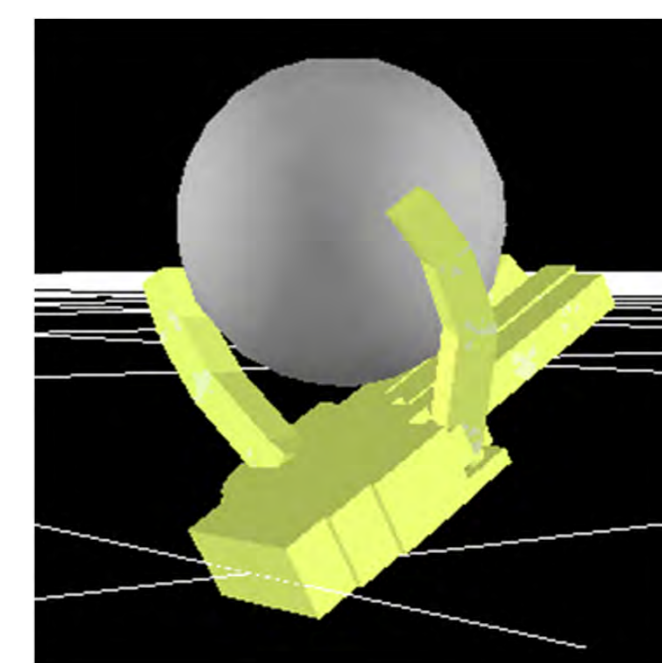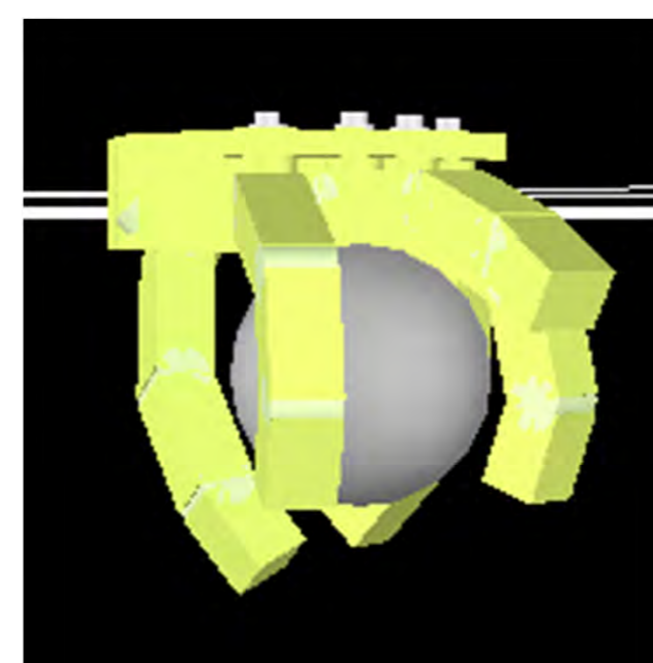   - -> More reachability for robot hands

Slip!

Fall down ...
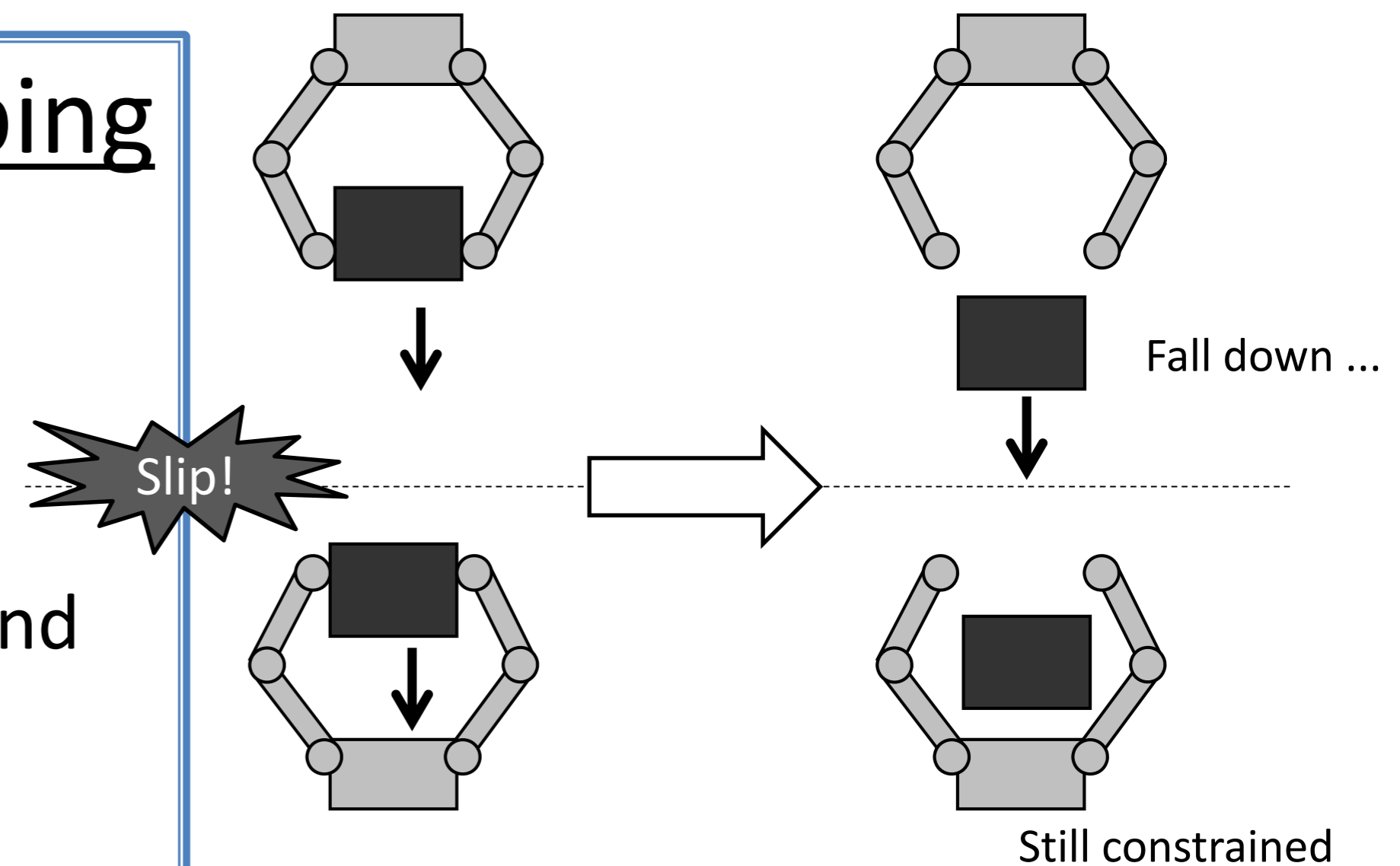
Still constrained

Partial Caging

- Objects are almost constrained geometrically and escape paths exist, but with either following conditions
    1. The escape paths are too constricted.
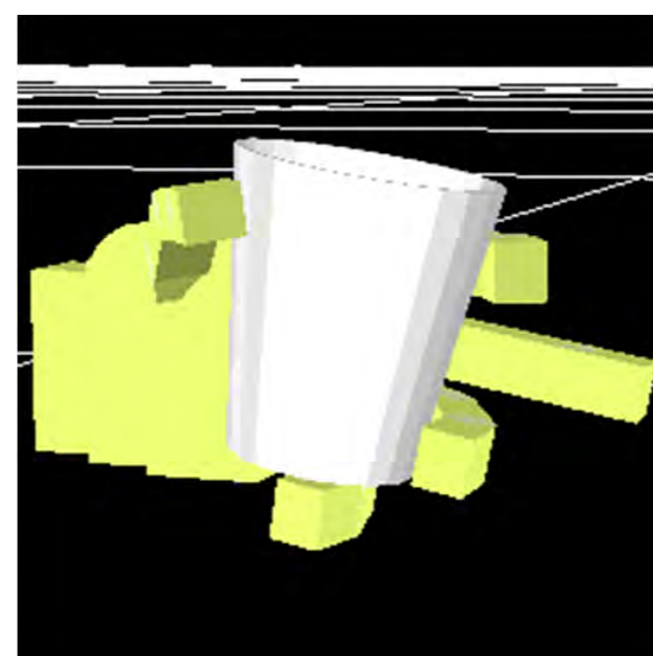   2. Some forces are applied to the objects to prevent them from escaping.
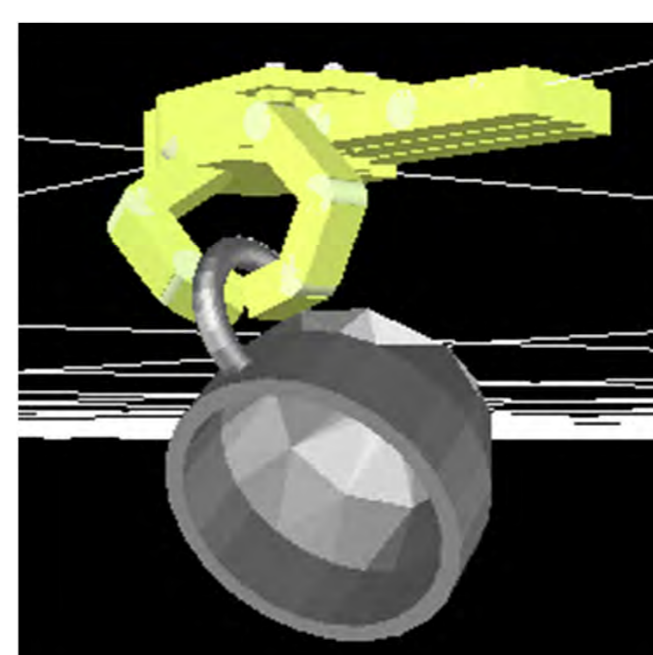

Gravitational force

Partial caging

(Complete) caging

Daily use equipment is often larger or smaller for a human hands to cage it...

Caging a ball by a human-like hand
$16.6 \leq d \leq 90$mm: completely caged
Otherwise: partially caged with consideration of the direction of gravitational force
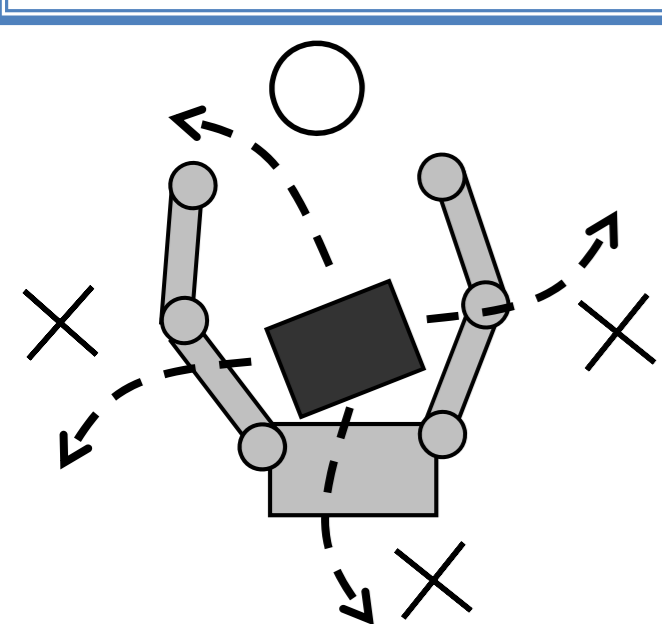

Partial caging for a paper cup
The thumb, index and ring finger surround the side face, and the little finger support the base face.

(Complete) Caging

- Objects are completely confined in the hand, and no escape paths exist.
- Sufficient conditions for some simple objects are derived with mechanical limitation of the hand.
- Low DOF robot hands can capture specific objects such like rings and dumbbells.
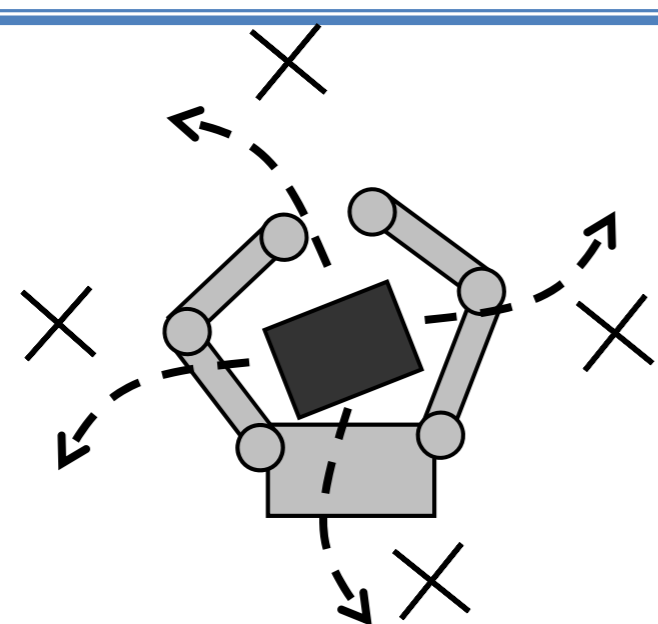

Complete caging for a mug
In simulations, ring-like objects could be robustly captured, but experiments sometimes failed because of the lack of joints torque.