

Survey of Manipulator End Effectors



Friction-Based Grasping Manipulators



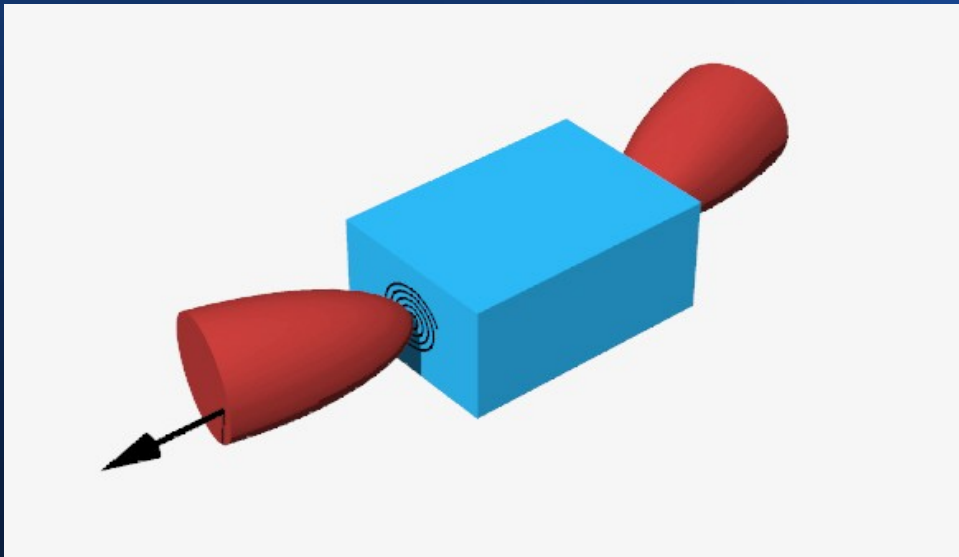
- Can range from simple parallel jaw-grippers to multi-fingered manipulators
- Simpler models of end-effectors require less grasp analysis, but may provide worse grasps

2-Point/Planar Contact Manipulators



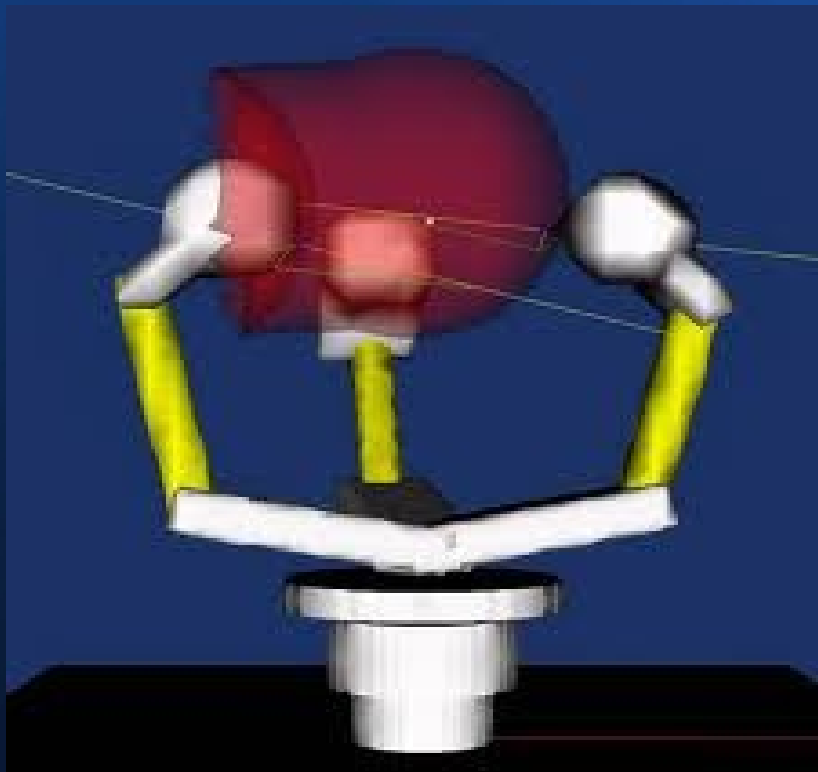
- Uses 2- point or 2- planar soft-finger contact friction between points on rigid body to ensure grasp.
- Is very versatile, but may not provide enough contact points for robust or delicate grasping.

2-Point/Planar Contact Manipulators



- These manipulators rely heavily on sensor data of object to develop a geometrical model.
- The robot can construct a grasp map using this model to achieve a grasp

Multi-Contact Point Hand Manipulators



- With more fingers, we can apply more point and planar contacts to object
- Assuming friction, with more contacts we can increase the chance of a stable force-closure grasp.

Multi-Contact Point Hand Manipulators

- The Barrett hand is an example of a manipulator that allows a great deal of flexibility



Multiple Contact Points/ Multiple Cooperative Manipulators



- As we increase the number of fingers, we can often increase the manipulation capabilities of the robot
- The DaVinci medical robot features 4 end effectors working in cooperation

Pros and Cons of Friction-Based Hand End Effectors

- May have a high-computational cost associated with grasp analysis
- Heavily dependent on sensor data
- Is appropriate for delicate and highly manipulable scenarios



Example: Ishikawa Komuro Lab's High Speed Hand



Other Manipulator End Effectors

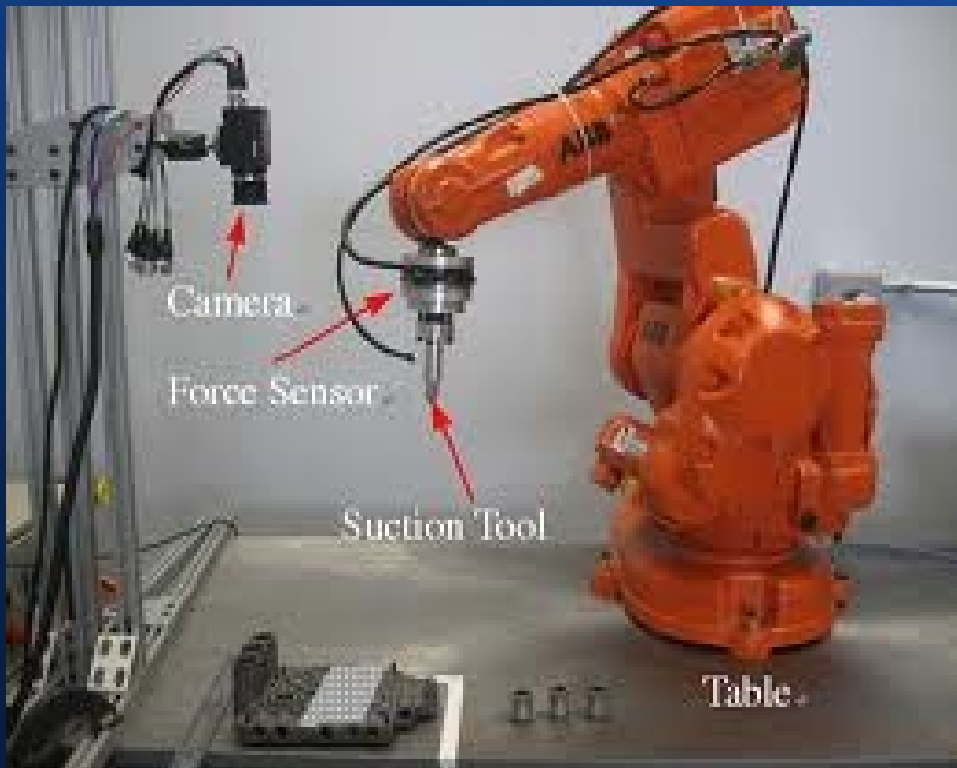
- While end effectors that use open-chain manipulators to achieve grasps allow a great degree of dexterity, there are other classes of manipulators that are also successful that do not require friction based contact

Suction-Based End Effectors

- Suction manipulators are good for low-weight, small objects
- Acceleration of end effector affects max load that suction gripper can carry for many objects



Suction-Based End Effectors



- Suction gripper end effectors are used often in industrial settings, since they require a vacuum system.
- Unless the object has a planar surface, precise manipulation can be difficult

Advantages/Disadvantages

- Suction based robots require less grasp analysis
- Are usually not appropriate for non-planar large objects
- Can manipulate rigid planar objects very well



Adept Quattro Robot



- The Adept Quattro robot is a high-speed industrial robot used for packing and sorting
- It uses a suction end effector to lift and place small objects

High-Speed Adept Quattro Manipulation



Motoman SK120 Manipulating Glass Sheets



Magnetic Gripper End Effectors



- Magnetic manipulation of metallic objects allows heavy and irregular objects to be manipulated
- Only viable for metallic objects

Disadvantages of Magnetic Grippers

- Manipulating the orientation of an object can be hard with a magnetic end effector
- When dealing with multiple metallic objects, it can be difficult to isolate and manipulate only one.
- Magnetic manipulation can affect sensitive electronic devices.

Hybrid Suction/Friction “Universal Gripper” End Effector

- Uses a balloon full of coffee grounds to produce an adaptive grasp that can allow manipulation of irregular objects
- Excellent versatility

