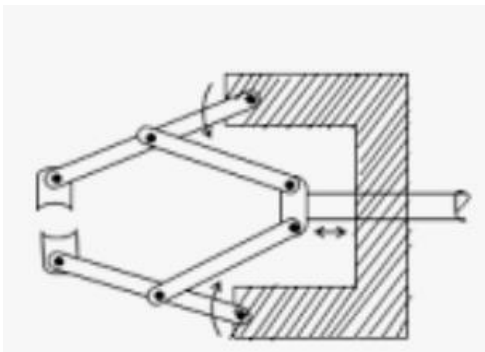
MECHANICAL GRIPPER

A mechanical gripper is used as an *end effector* in a robot for grasping the objects with its *mechanically* operated fingers. In industries, two fingers are enough for holding purposes. More than three fingers can also be used based on the application. As most of the fingers are of *replaceable* type, it can be easily removed and replaced.



A robot requires either hydraulic, electric, or pneumatic drive system to create the input power. The power produced is sent to the gripper for making the fingers react. It also allows the fingers to perform open and close actions. Most importantly, a *sufficient force* must be given to hold the object.

In a mechanical gripper, the holding of an object can be done by *two different methods* such as:

- Using the finger pads as like the shape of the work part.
- Using soft material finger pads.

In the first method, the contact surfaces of the fingers are designed according to the work part for achieving the *estimated shape*. It will help the fingers to hold the work part for some extent.

In the second method, the fingers must be capable of supplying sufficient force to hold the work part. To avoid scratches on the work part, *soft type pads* are fabricated on the fingers.. This method is very simple and as well as *less expensive*. It may cause slippage if the force applied against the work part is in the parallel direction. The slippage can be avoided by designing the gripper based on the force exerted.

$\mu \, n_f \, F_g = w$ ………………… 1

where,

μ => co –efficient of friction between the work part and fingers

n_f => no. of fingers contacting

F_g => Force of the gripper

w => weight of the grasped object

The equation 1 must be *changed* if the weight of a work part is more than the force applied to cause the slippage.

$\mu \, n_f \, F_g = w \, g$ …..…………….2

g => g factor

During rapid grasping operation, the work part will get *twice* the weight. The g factor in the equation 2 is used to calculate the acceleration and gravity.

The *values of g factor* for several operations are given below:

g = 1 –acceleration supplied in the opposite direction.

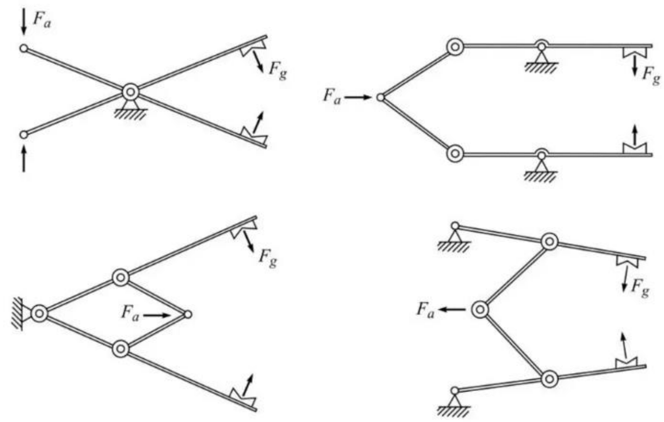
g = 2 –acceleration supplied in the horizontal direction.

g = 3 –acceleration and gravity supplied in the same direction.

Mechanical grippers are classified according to the type of kinematics

1.Linkage actuation:

The design of the linkage determines how the input force Fa to the gripper is converted in to the gripping force Fg applied to the fingers. Other features like how wide the gripper finger will open and how quickly the gripper will actuate.



Gear and Rack actuation:

The rack gear would be attached to a piston or some other mechanism that would provide a linear motion .Movement of rack would drive two partial pinion gears and these would in turn open and close the fingers.

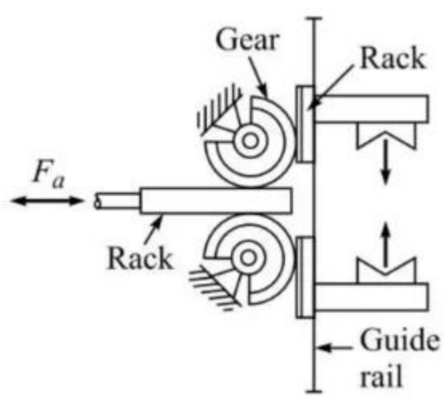


Fig. 5.7 *Gear-and-rack method of actuating the gripper.*

Cam actuation:

Cam Actuated gripper have a spring loaded follower which provide opening and closing action of the gripper. movement of cam in one direction will open the gripper while movement of gripper in opposite direction will close the gripper.

Advantage:

Spring action would accommodate different part size.

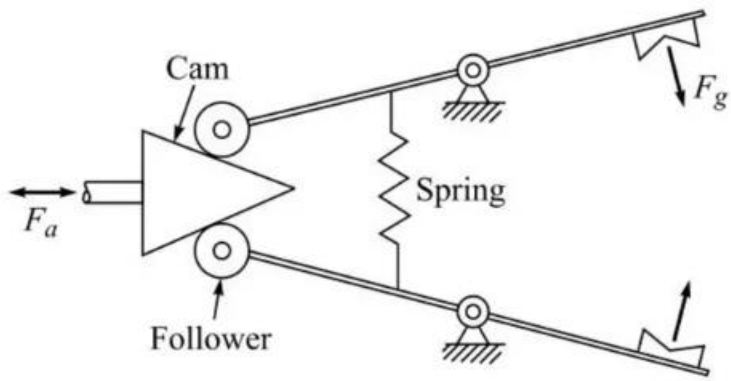


Fig. 5.8 *Cam-actuated gripper.*

Screw actuation:

The screw is turned by a motor. When the screw is rotated in one direction the thread block moves in one direction . when the screw is rotated in opposite direction the thread block moves in opposite direction. The threaded block is in turn connected to the gripper finger to cause the gripper finger to cause corresponding opening and close.

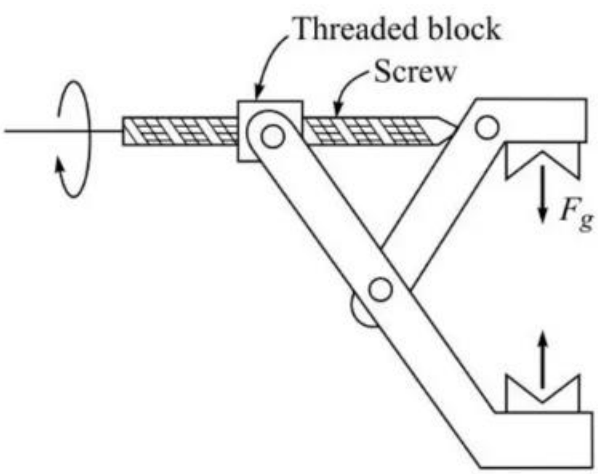


Fig. 5.9 *Screw-type gripper actuation.*

Rope and Pulley Actuator in Industrial Robotics

Definition

A **rope and pulley actuator** uses a flexible element (rope, steel cable, or belt) wound around pulleys to transmit motion from the actuator (motor or cylinder) to the robot's joint or gripper.

Instead of rigid links, the rope/belt transfers force through tension. The actuator pulls the rope, and this movement is translated into **joint rotation, linear sliding, or gripping action**.

Working Principle

1. An actuator (usually an **electric motor**) rotates a pulley.
2. A rope/cable is wound around pulleys fixed along the joint path.
3. As the rope moves under tension, it **pulls or releases** the driven link (such as a gripper jaw or robotic finger).
4. Springs or counter-ropes may be used to restore the original position.