Introduction to Robotics
CSE 461

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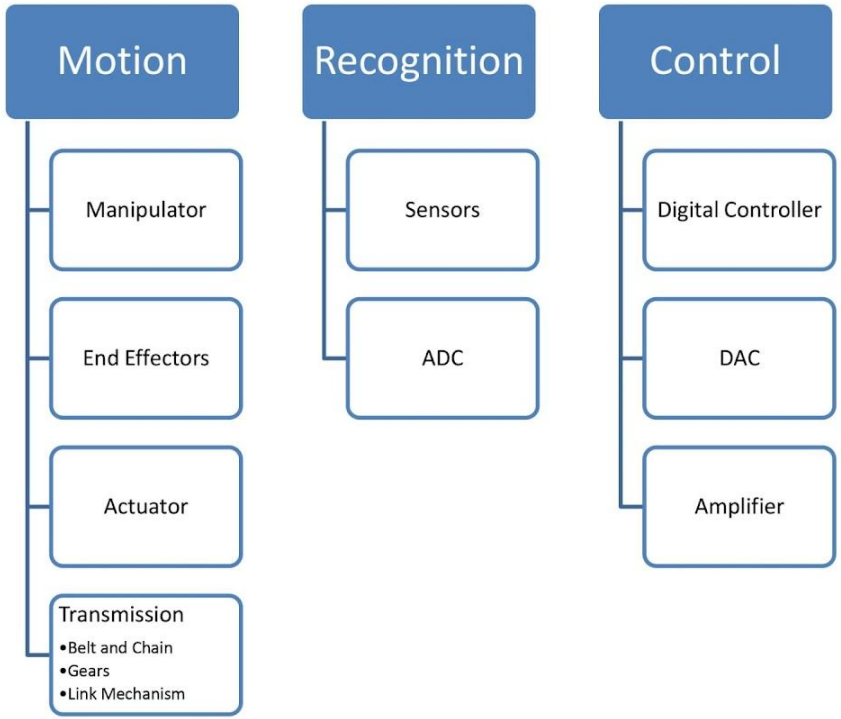
Brac University
Lecture 4: Chapter 1(Introduction to robotics: basics)

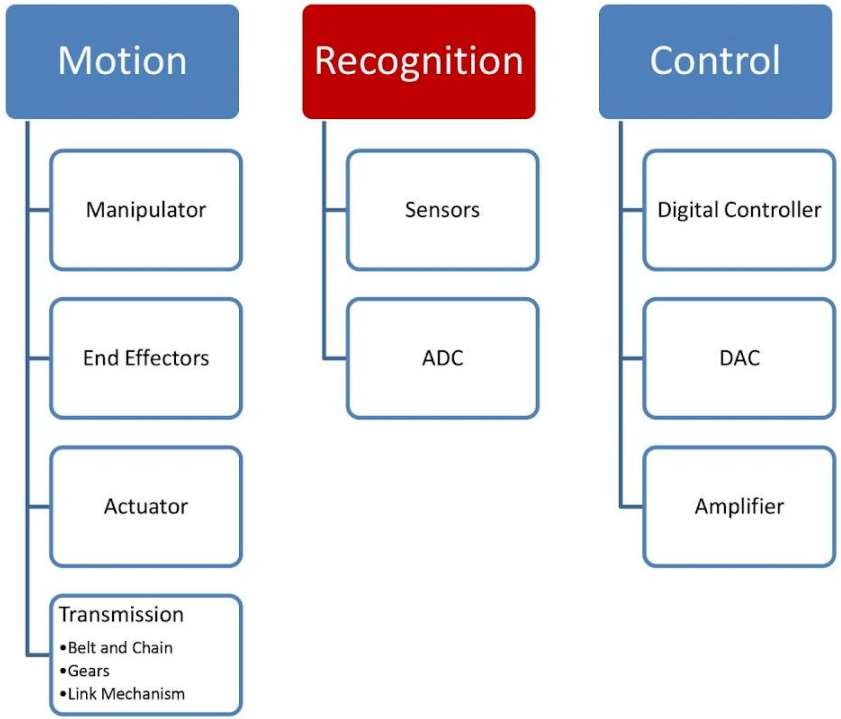
Previous Class

1. Paradigms

Subsystems


Motion
Manipulator
End Effectors
Actuator
Transmission
•Belt and Chain
•Gears
•Link Mechanism
Recognition
Sensors
ADC
Control
Digital Controller
DAC
Amplifier

Subsystems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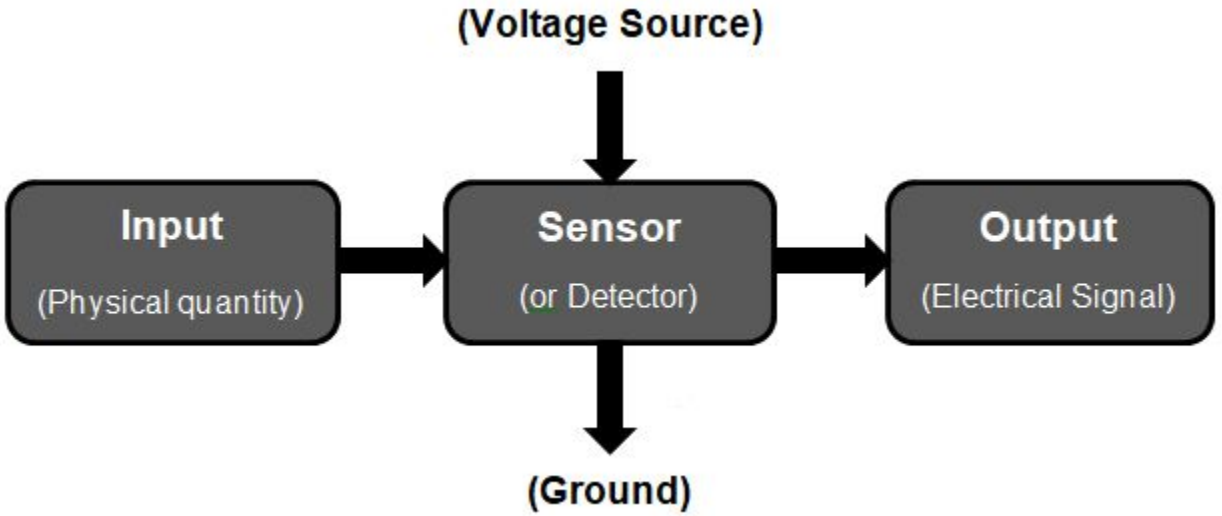
Sensor

A sensor is a device that detects or measures physical, chemical, or biological properties of the environment or a system and converts them into a signal that can be processed or analyzed.



Sensor Examples

Recognition

Physical Property	Sensor
contact	switch
distance	ultrasound, radar, infrared
light level	photocells, cameras
sound level	microphone
rotation	encoders and potentiometers
acceleration	accelerometers gyroscopes

More Sensor Examples

Recognition

Physical Property	Sensor
magnetism	compass
smell	chemical
temperature	thermal, infra red
inclination	inclinometers, gyroscopes
pressure	pressure gauges
altitude	altimeters
strain	strain gauges

Active sensors

Passive sensors

Ultrasonic Sensor

Converts electrical energy into acoustic wave, which is an ultrasonic wave travelling at above 18kHz frequency.

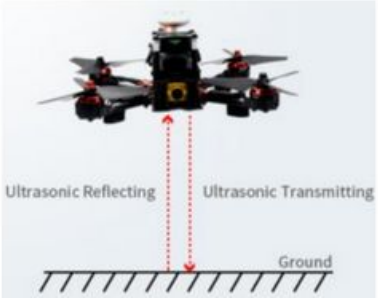
- HC-SR04 operates at 40kHz

a microcontroller is used for communication with an ultrasonic sensor.

HC-SR04 Ultrasonic Sensor
(*Source: Digikey*)

Applications

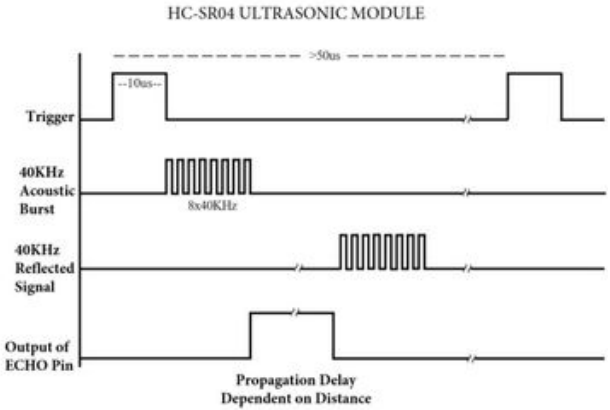
- Measure wind speed and direction
- Navigation of UAV
- Measure tank depth



Ultrasonic sensor measuring height during drone's flight.
(*Source: RadioLink*)

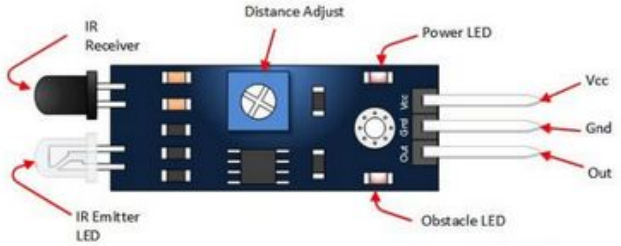
Ultrasonic Sensor: How It Works??

1. a microcontroller is used for communication with an ultrasonic sensor.
2. To begin measuring the distance, the microcontroller sends a trigger signal to the ultrasonic sensor. The duty cycle of this trigger signal is 10µS for the HC-SR04 ultrasonic sensor.
3. When triggered, the ultrasonic sensor generates eight acoustic (ultrasonic) wave bursts and initiates a time counter.
4. As soon as the reflected (echo) signal is received, the timer stops. The output of the ultrasonic sensor is a high pulse with the same duration as the time difference between transmitted ultrasonic bursts and the received echo signal.

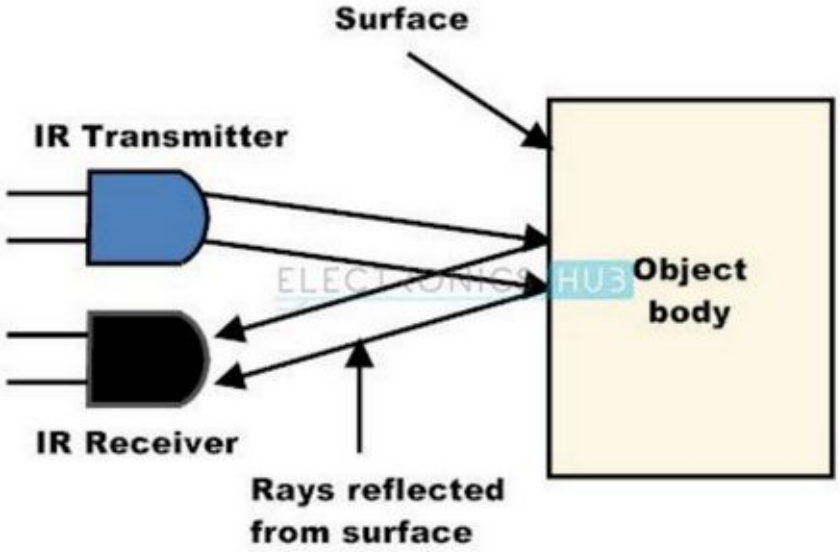


Infrared Sensors

- An electronic device that can detect and measure infrared (IR) radiation in the environment
- Anything that emits heat (everything that has a temperature above around five degrees Kelvin) gives off infrared radiation
- Applications
  - TV Remote
  - Motion Sensing
  - Proximity Sensing



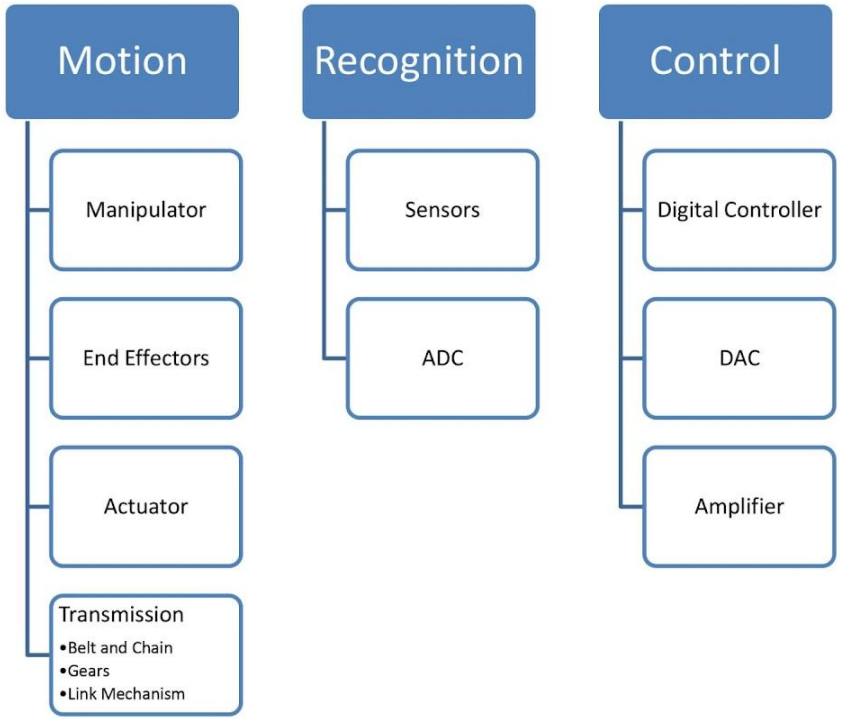
Infrared Sensors: How Active Sensing Works



Lidar

- Laser generates an optical pulse(*Up to 200,000+ pulses/second*)
- After reflecting off an object, the pulse returns to the receiver sensor
- High-speed counter measures the time of flight from the start pulse to the return pulse
- Time measurement is converted to a distance
- An onboard computer records each laser's reflection point, translating this rapidly updating "point cloud" into an animated 3D representation of its surroundings.

Subsystems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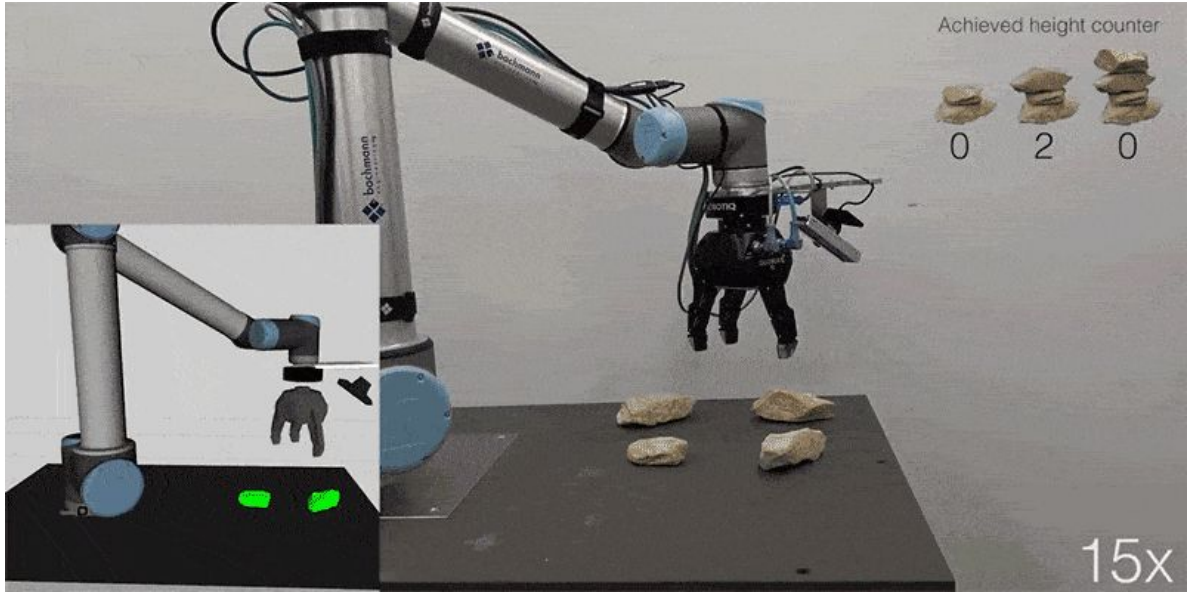
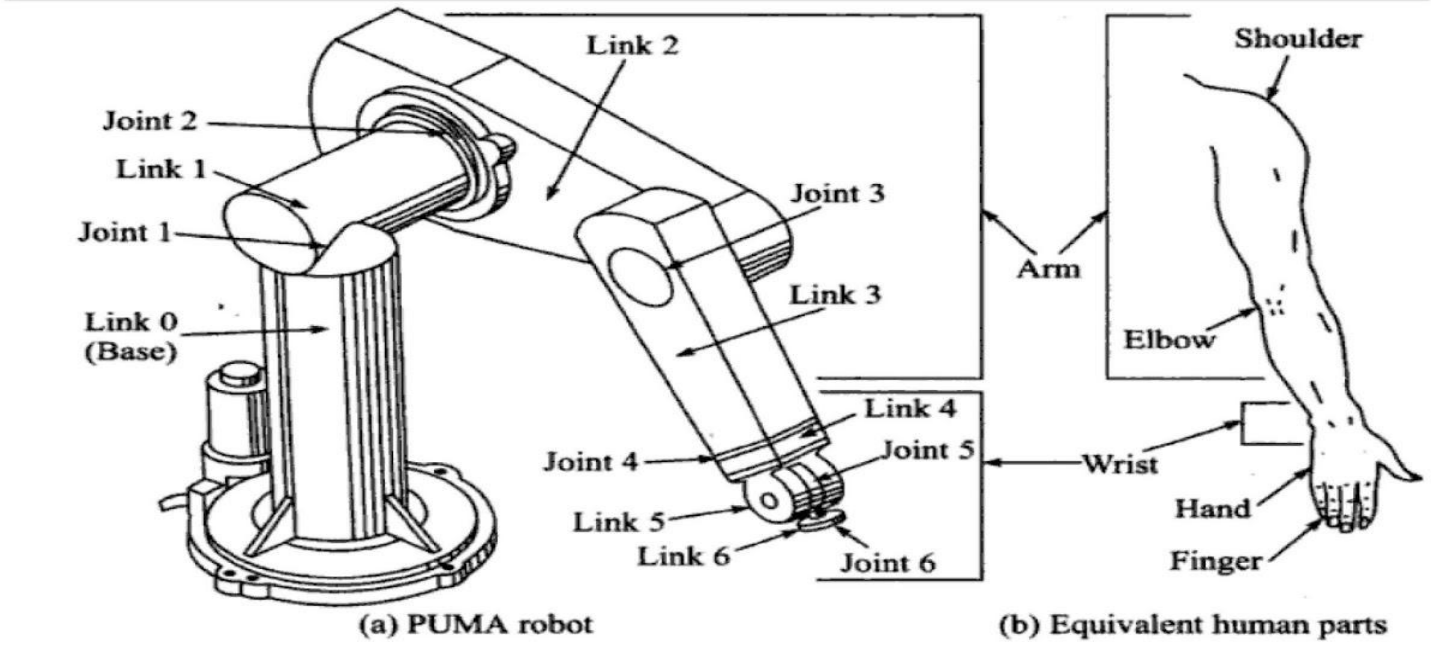

Achieved height counter
0 2 0
15x

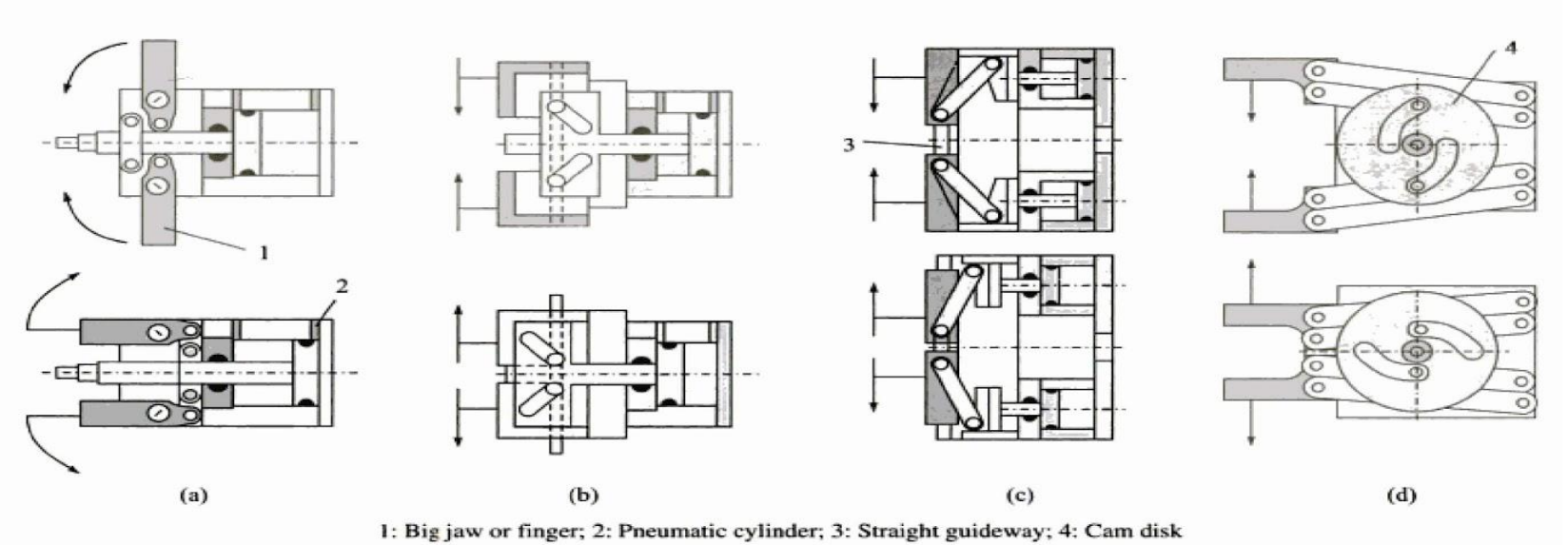
Motion

Manipulator



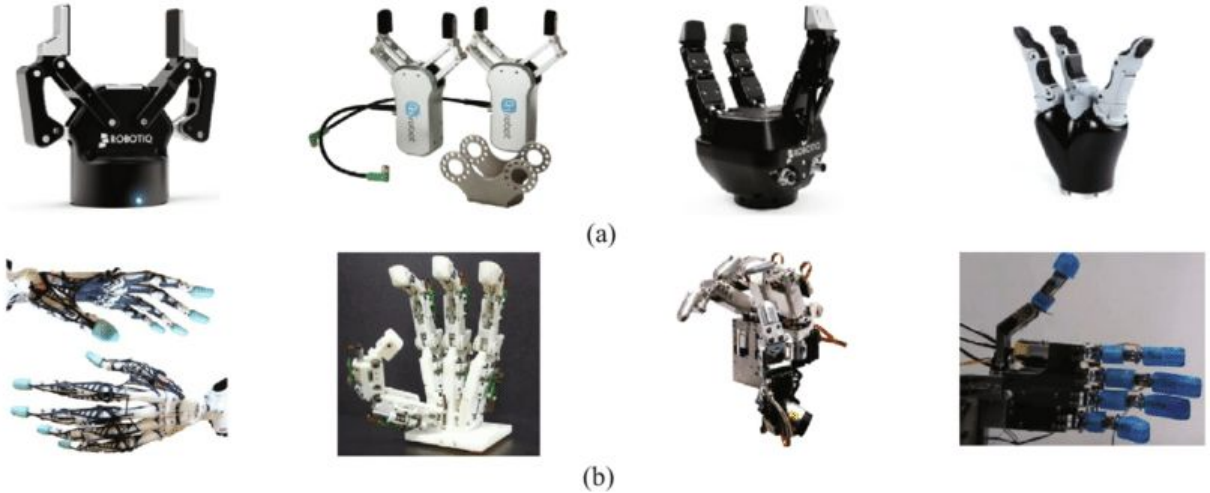
Motion

End-effector



1: Big jaw or finger; 2: Pneumatic cylinder; 3: Straight guideway; 4: Cam disk

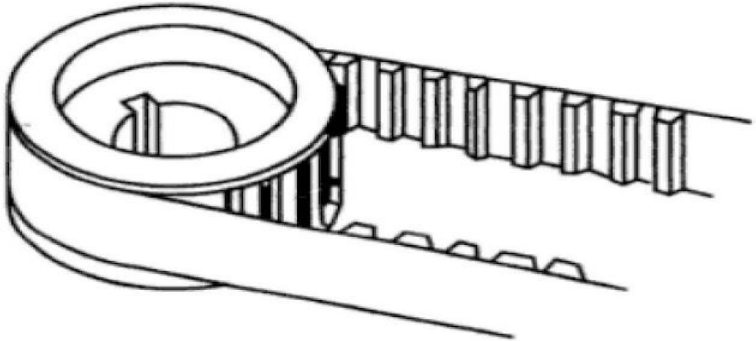
End Effector



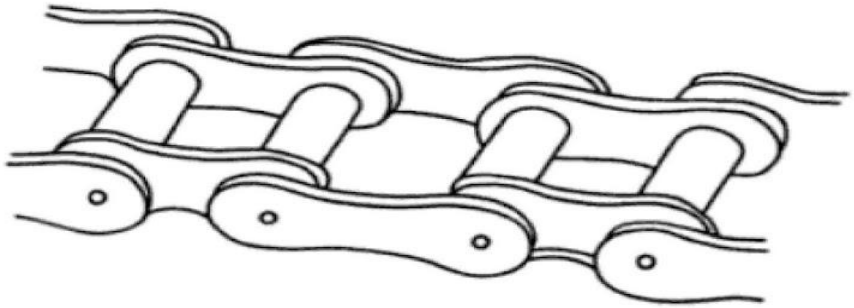
Two types of fingered end-effectors: (a) gripper type, (b) anthropomorphic type

Motion

Transmission (Belt and chain)



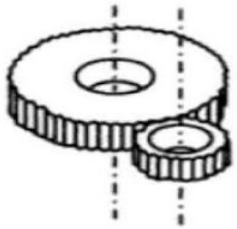
(a) Synchronous belt



(b) Roller chain

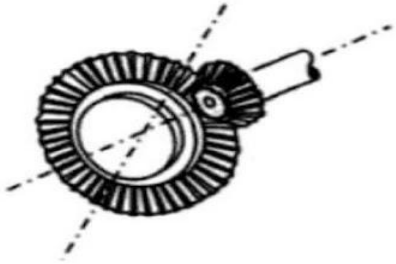
Motion

Transmission (Gears)



Spur gears

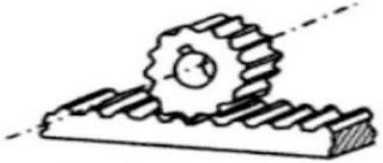
Helical gears



Straight bevel

Spiral bevel

Worm



Rack and pinion

Motion

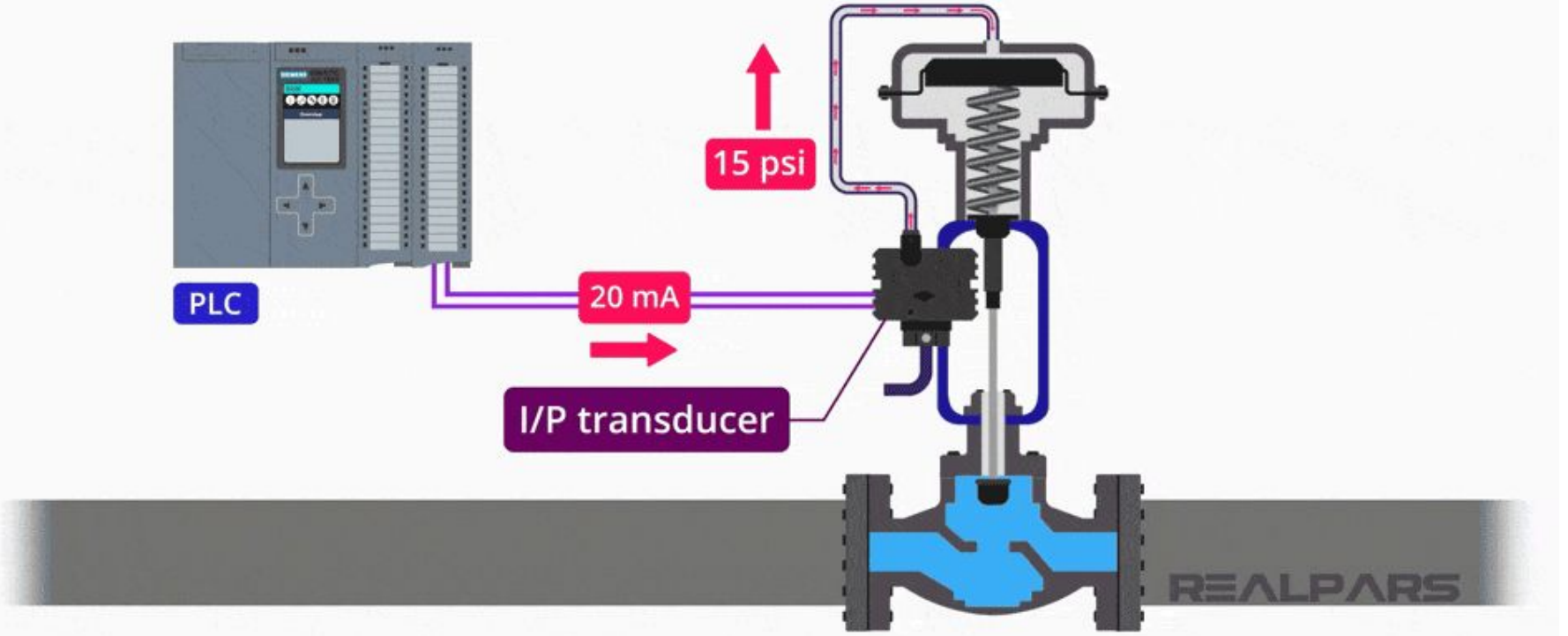
Actuators

Pneumatic Actuator

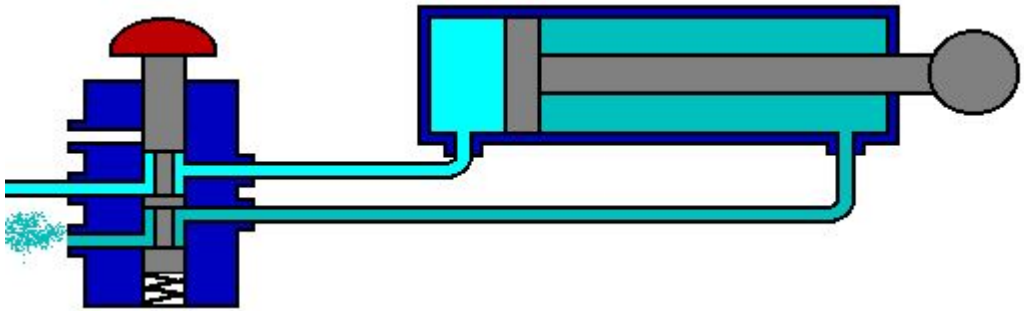
Hydraulic Actuator

Electric Actuator

Pneumatic



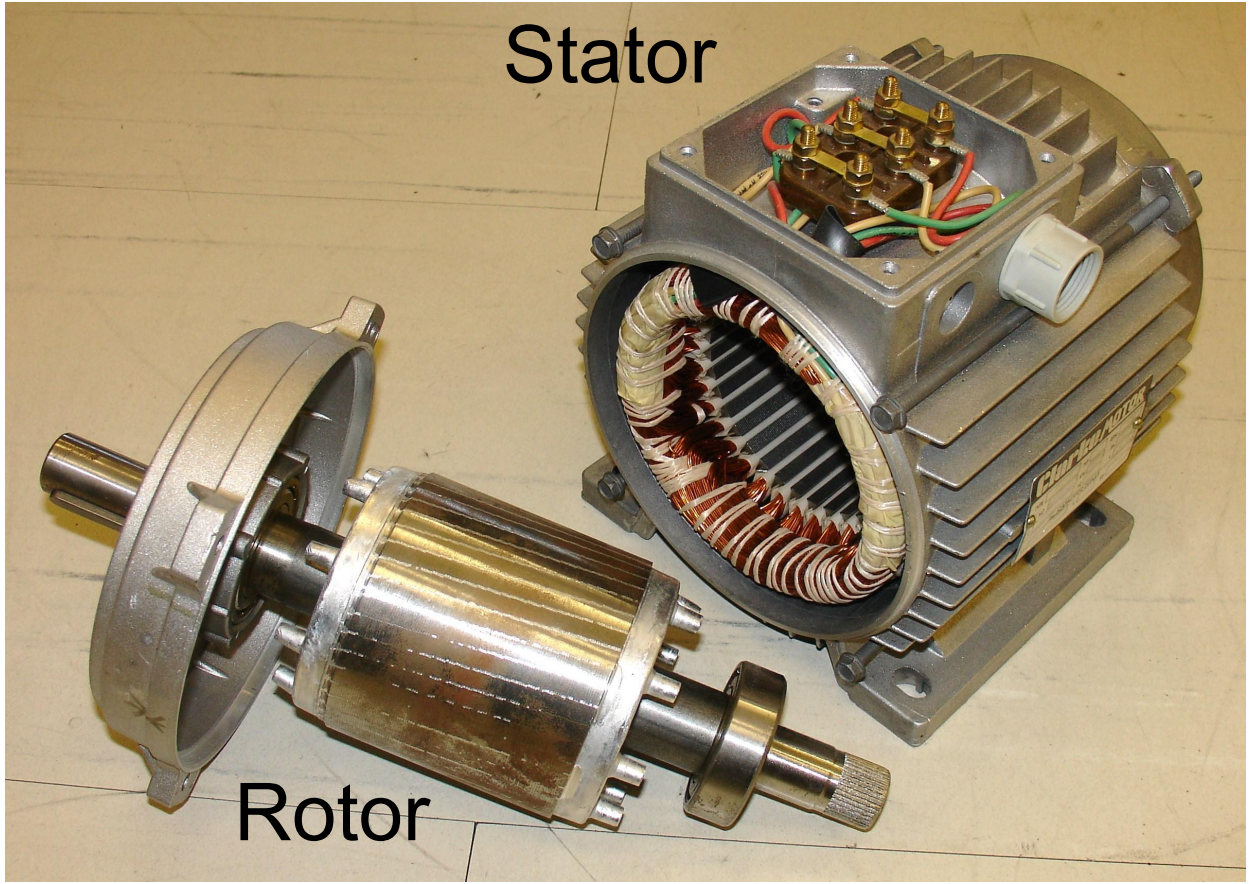
Hydraulic



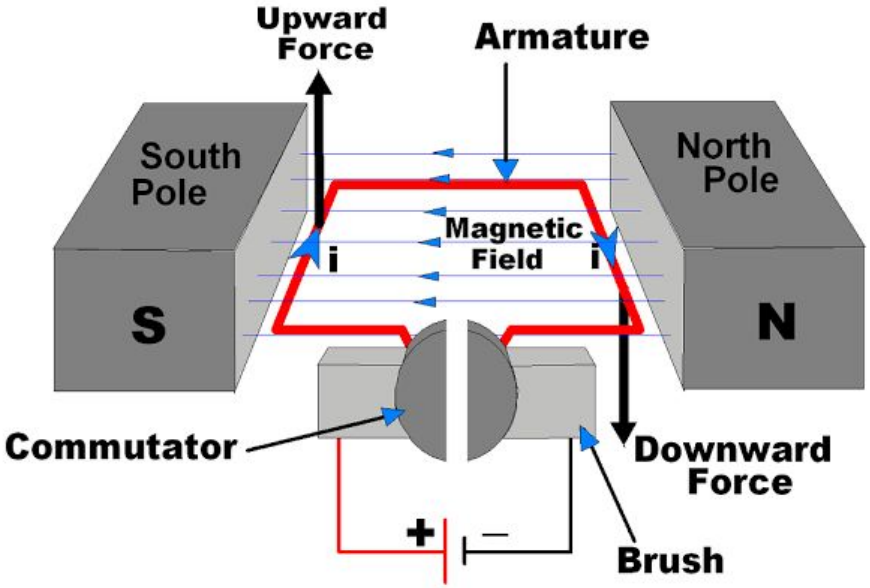
Electric

Characteristics	Pneumatic	Hydraulic	Electric
Efficiency	Low	Low	High
Reliability	Excellent	Good	Good
Maintenance	High user-maintenance	High user-maintenance	Little to no maintenance
Purchase Cost	Low	High	High
Operating Cost	Moderate	High	Low

Motor



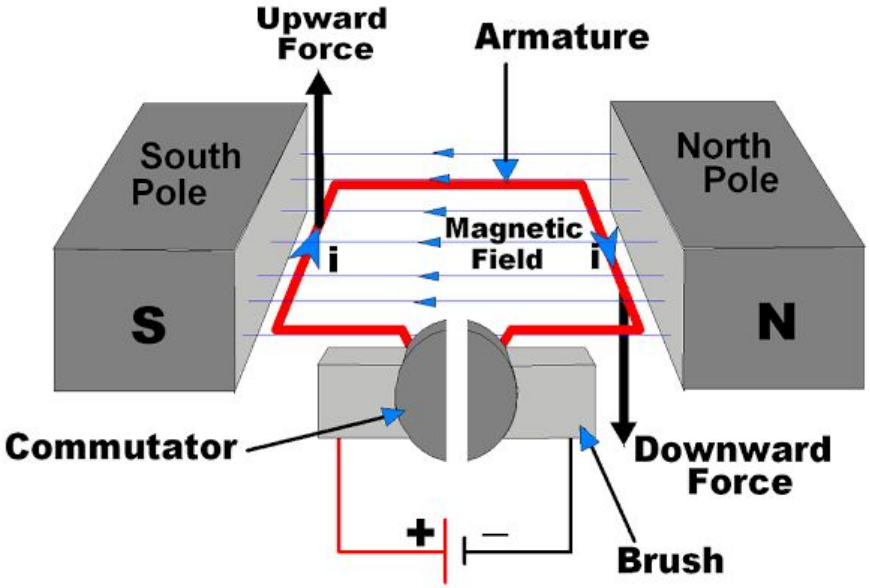
DC motor



DC Motor Conceptual Diagram

https://youtu.be/LAtPHANEfQo

DC motor



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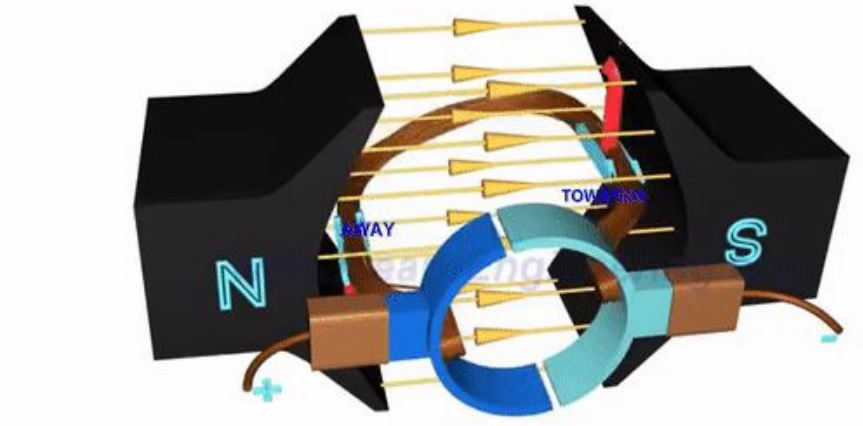

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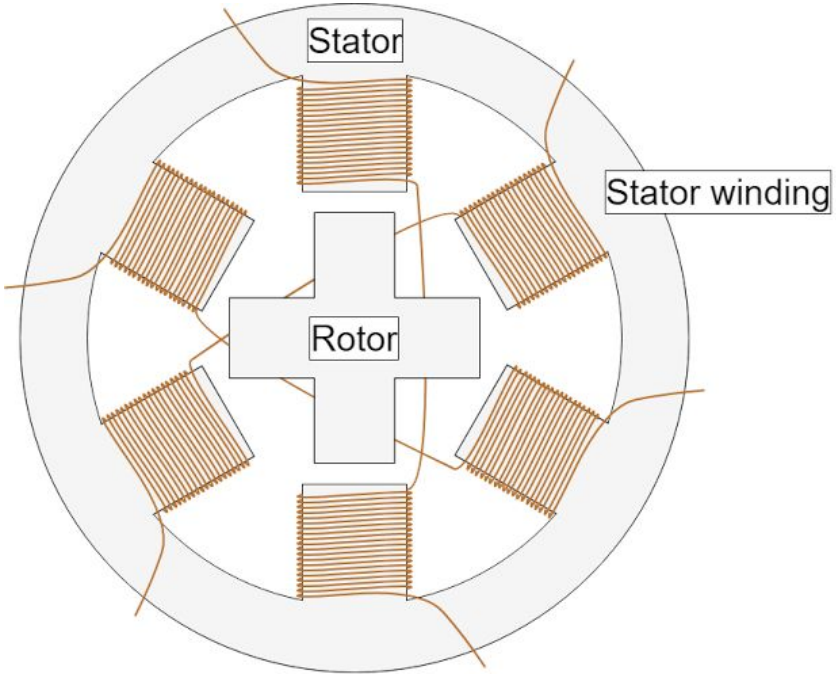
Stepper Motor



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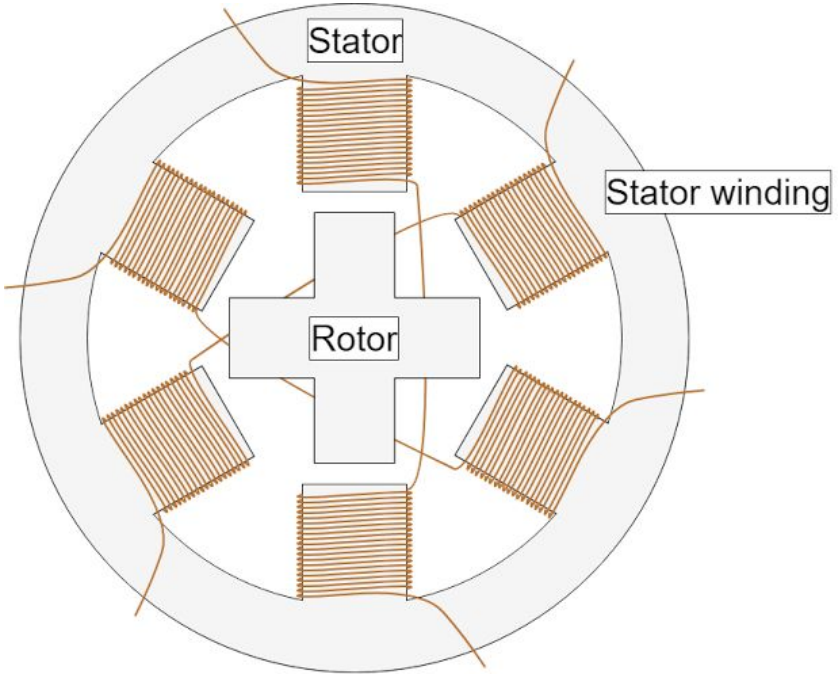
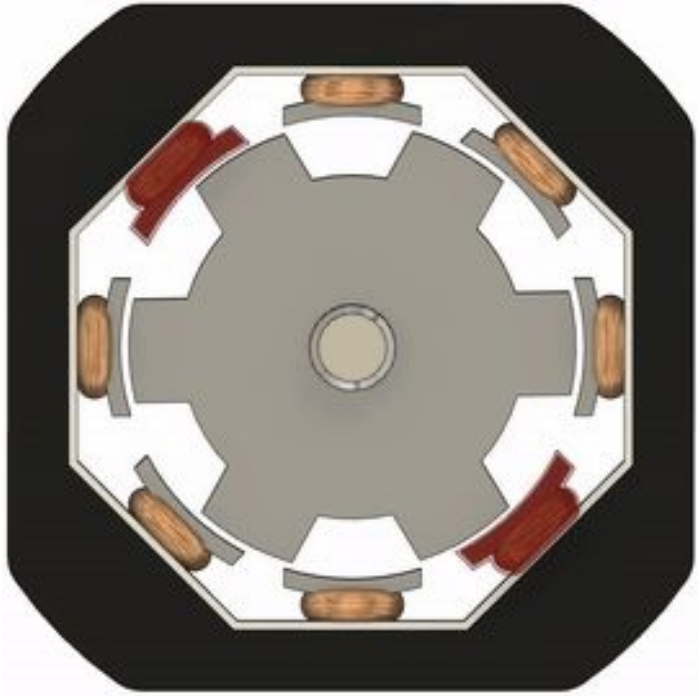
Stepper Motor





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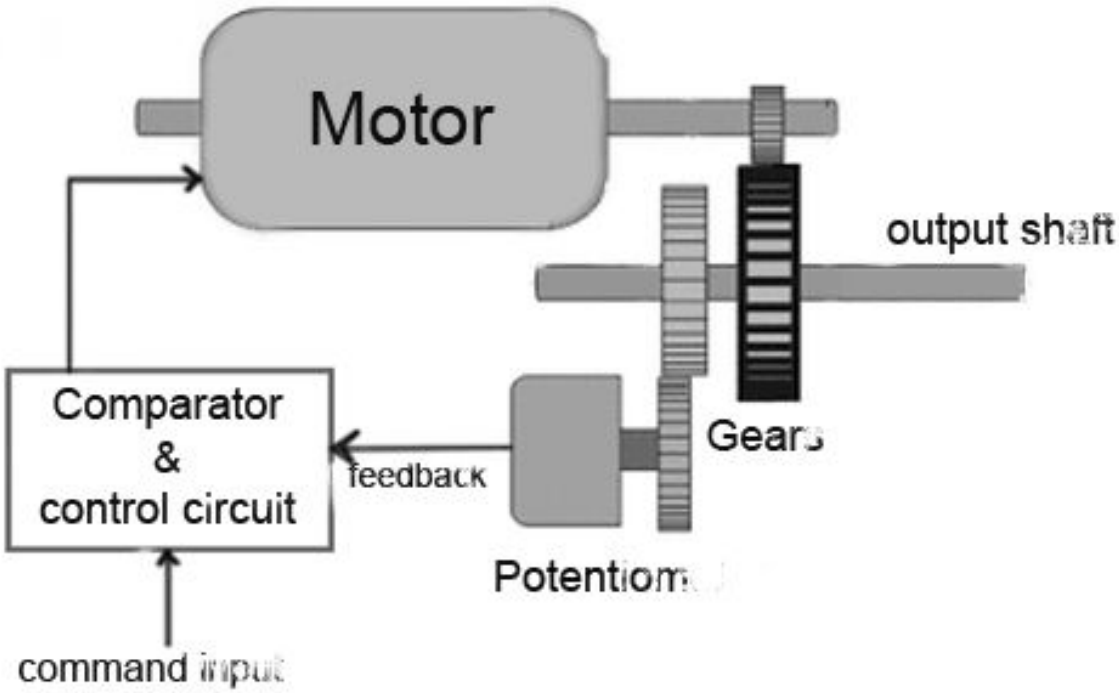
Servo Motor


Motor
output shaft
Comparator
&
control circuit
feedback
command input

Next Class

- Quiz

Thank You