

CSE444: Introduction to Robotics

Working with Actuators

Fall-2020



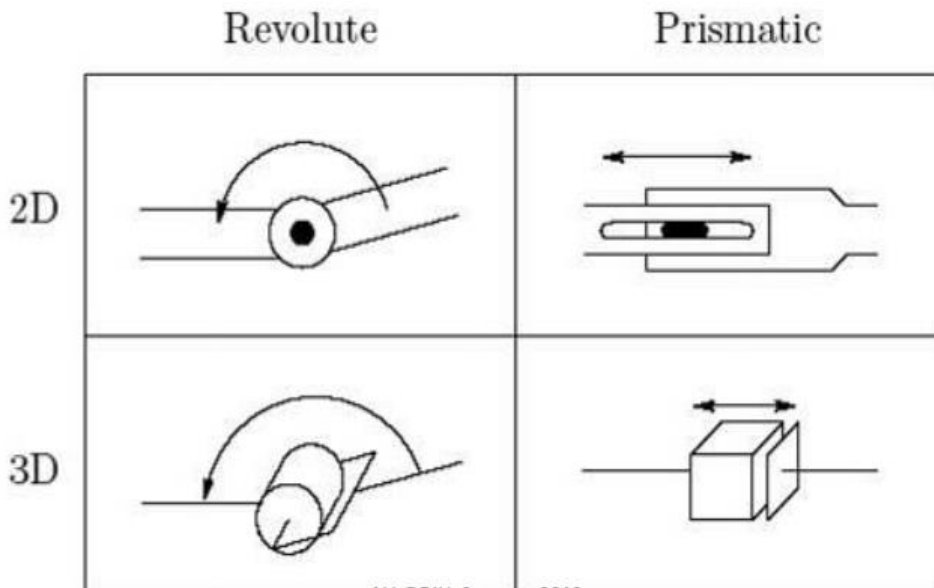
What is actuator?

□ Definition:

- An actuator is a component of a machine that is responsible for **moving and controlling** a mechanism or system.
- It takes energy, usually transported by air, electric current, or liquid, and converts that into some kind of motion.
- or A device used to transfer motion from one object to another is called an actuator. It activates a movement or a process.
- An actuator is **also called transducer** because it converts one form of energy into another form according to transduction principle.

What is actuator?

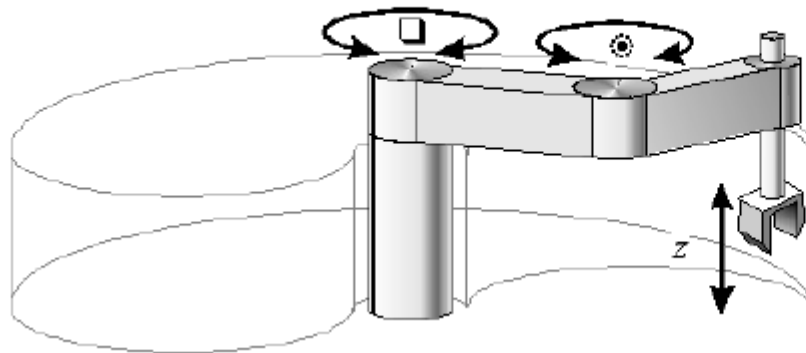
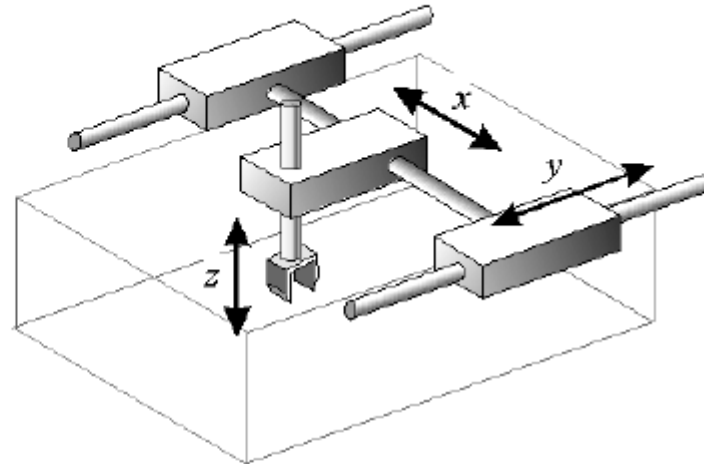
Robot Joints: Robots joints can be either **rotary** (revolute) or **prismatic** (telescoping).



What is actuator?

Robot Joints (cont...)

Prismatic Cartesian
robot



Rotary SCARA
robot

Types of actuators


Actuator Control

1. Robots are classified by control method into **servo** and **non-servo** robots
2. *Non-servo robots* are essentially **open-loop** devices whose movements are limited to predetermined mechanical stops
3. *Servo robots* use **closed-loop** computer control to determine their motion

Types of actuators

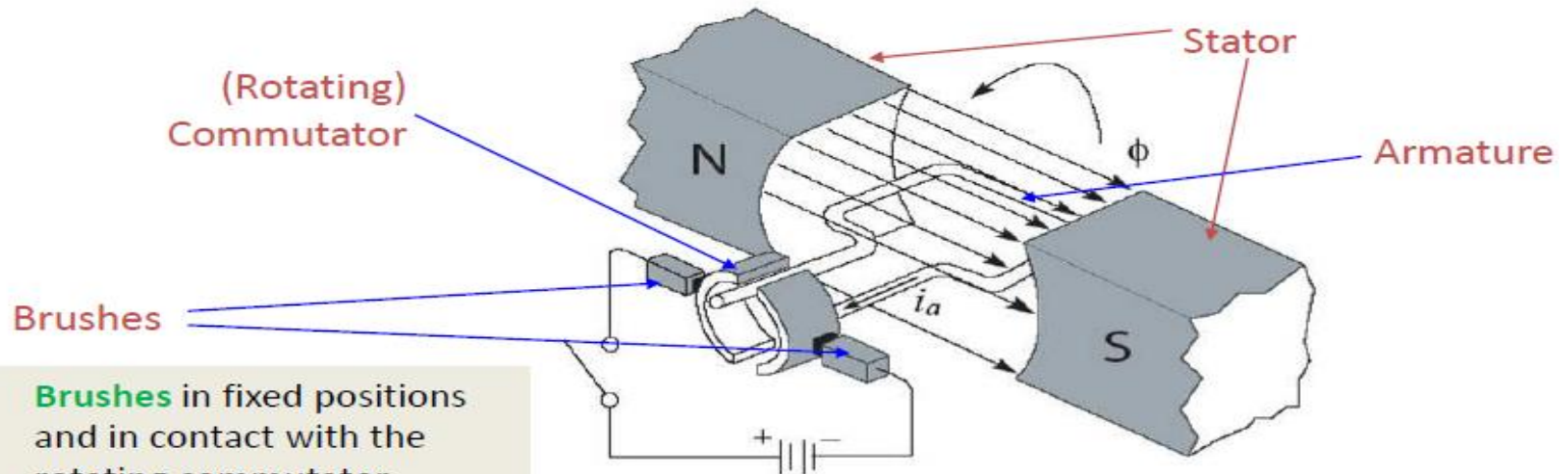
Electrical actuator types

Machine which converts **electrical energy** into **mechanical energy**

- DC-motors.
 - Stepper motors.
 - Brushless DC motors.
 - Synchronous motors.
 - Asynchronous motors.
- Not discussed**
- 

DC Motor

- The principle components of an electric motor are:
 1. North and south **magnetic poles** to provide a strong magnetic field.
 1. Being made of bulky ferrous material they traditionally form the outer casing of the motor and collectively form the **stator**
 2. An **armature**, which is a **cylindrical ferrous core rotating within the stator** and carries a large number of windings made from one or more conductors



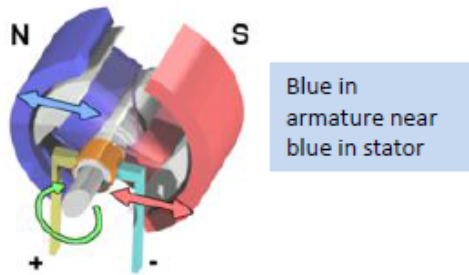
Brushes in fixed positions and in contact with the rotating commutator contacts. They carry direct current to the coils, resulting in the required motion

A **commutator**, which rotates with the armature and consists of copper contacts attached to the end of the windings

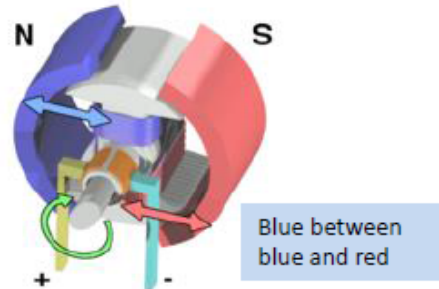
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DC Motor

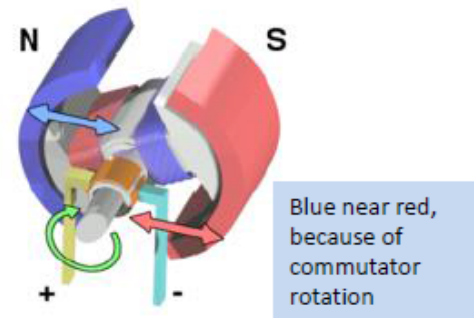
How Do Electric Motors Work? (cont...)



Blue in armature near blue in stator



Blue between blue and red

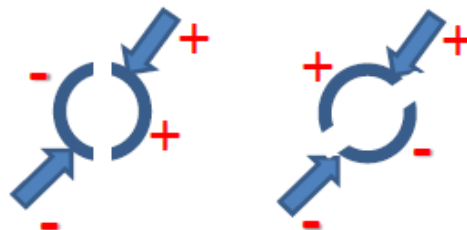


Blue near red, because of commutator rotation

1. A simple DC electric motor: when the coil is powered, a magnetic field is generated around the armature.
2. The **left** side of the armature is **pushed away** from the left magnet and **drawn toward the right**, causing rotation

The armature continues to rotate

- When the armature becomes *horizontally aligned*, the **commutator reverses the direction of current** through the coil, *reversing the magnetic field*.
- The process then repeats.



DC Motor

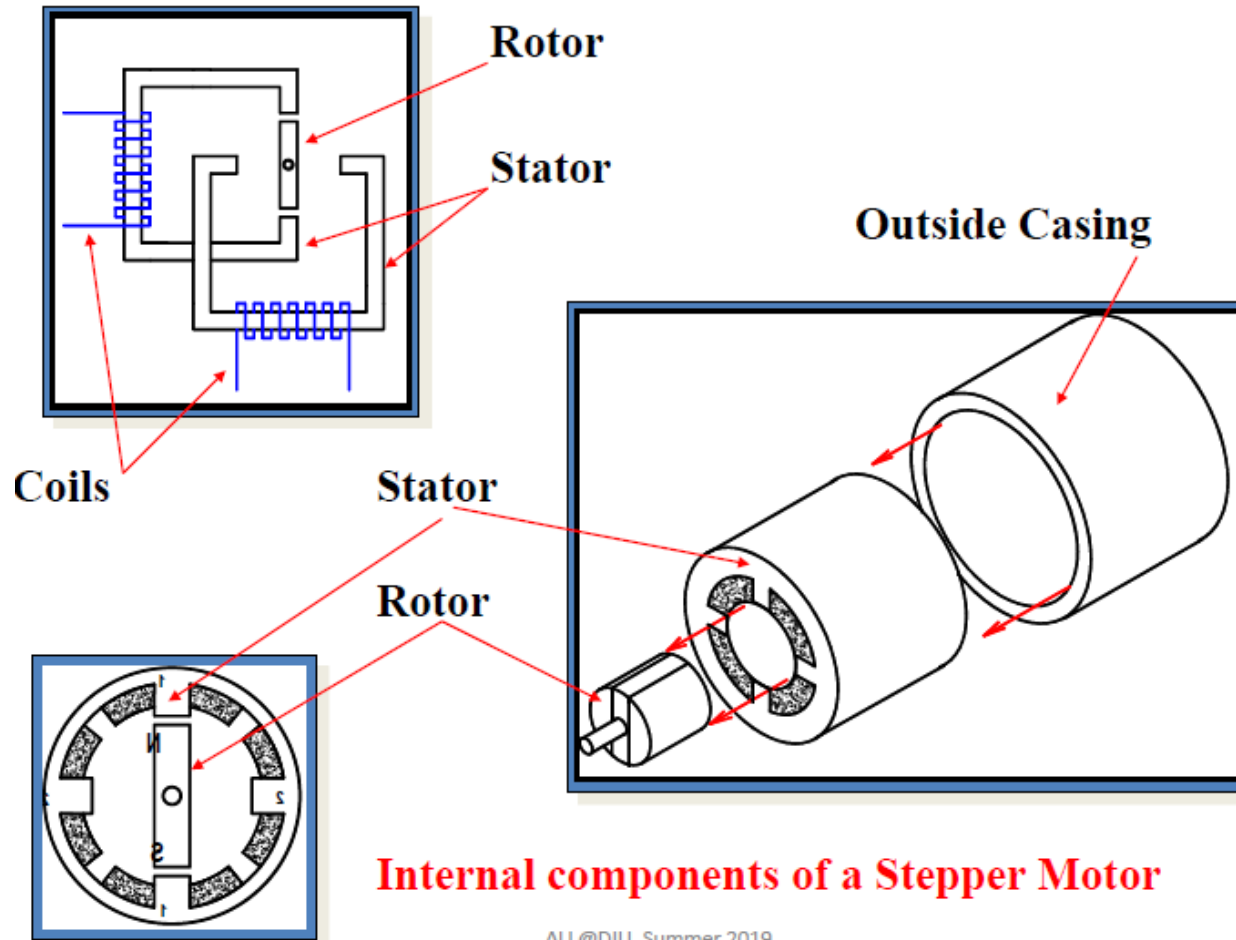
□ Application of Electric Motors

- Usually have **small rating**, ranging up to a **few horsepower**.
- They are used in **small appliances**, **battery operated vehicles**, for medical purposes and in other **medical equipment** like x-ray machines.
- Electric motors are also used in **toys**, and in **automobiles** as auxiliary motors.
 - For the purposes of seat adjustment, power windows, sunroof, mirror adjustment, engine cooling fans and the like.

Stepper Motor

- When **incremental rotary motion** is required in a robot, it is possible to use **stepper motors**.
- A stepper motor possesses the ability to move a **specified number of revolutions or fraction of a revolution** in order to achieve **a fixed and consistent angular movement**.
- This is achieved by **increasing the numbers of poles** on both rotor and stator.

Stepper Motor

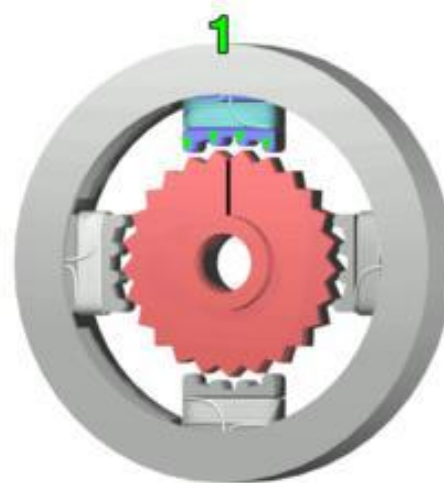


Internal components of a Stepper Motor

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Stepper Motor

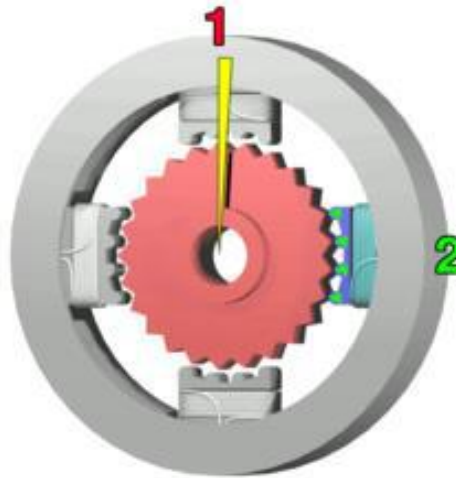
How does a stepper motor work?



The top electromagnet (**1**) is charged, attracting the topmost four teeth of sprocket.

Stepper Motor

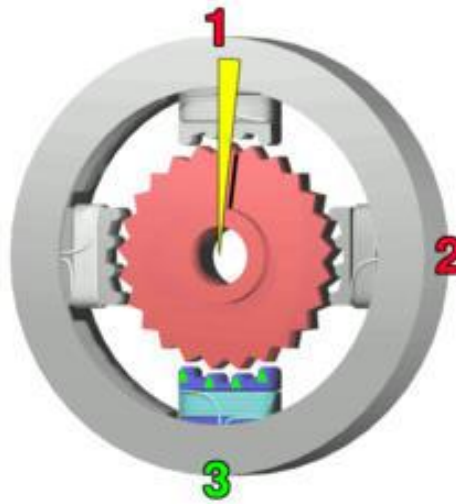
How does a stepper motor work?(cont.)



The top electromagnet (1) is turned off, and the right electromagnet (2) is charged, pulling the nearest four teeth to the right. This results in a rotation of 3.6° .

Stepper Motor

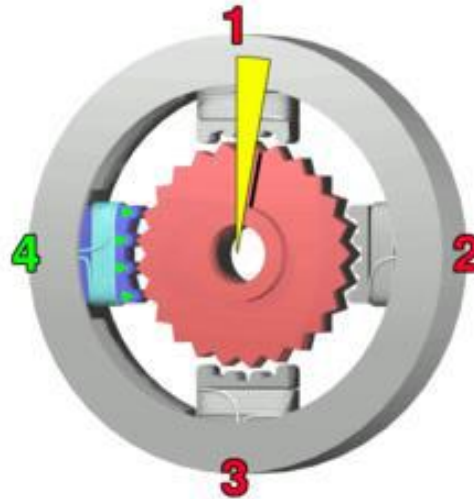
How does a stepper motor work?(cont.)



The bottom electromagnet (**3**) is charged, another 3.6° rotation occurs.

Stepper Motor

How does a stepper motor work?(cont.)

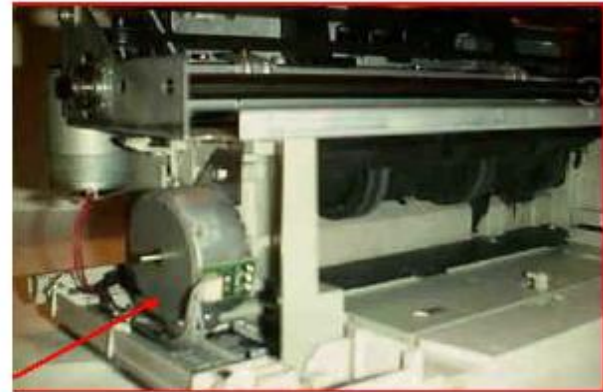


The left electromagnet (4) is enabled, rotating again by 3.6° . When the top electromagnet (1) is **again** charged, the teeth in the sprocket will have rotated by one tooth position; since there are 25 teeth, it will take 100 steps to make a full rotation.

Stepper Motor

Stepper motor applications

Paper feeder on printers



Stepper motors



CNC lathes