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).

![Diagram showing revolute and prismatic joints in 2D and 3D](image-url)
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. **Not discussed**
- Asynchronous motors.
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

![Diagram of a DC Motor]

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

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.

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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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The top electromagnet (1) is charged, attracting the topmost four teeth of sprocket.
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°.
How does a stepper motor work?(cont.)

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