→ Actuators in mobile robotics.

Actuator 'is' an active device that converts a primary energy source into physical movement.

Two classifications:

- The type of primary energy (used to generate motion in the actuator)
- Type of generated movement.

↳ Type of primary energy

- Eletrical: Transform primary eletrical energy (from battery) into the intended movement. Main class of actuators in robotics. Diverse and adaptable.

- Pneumatic: Powered by energy stored as compressed air. Used in situations where accurate and easy to control movements is required but the force is not a critical criteria. Very high pressures, robust. less efficient in converting energy than eletric.

- Hydraulic: Flow and pressure of fluid to convert the primary energy into linear and/or rotational motion or torque. Used when force required is extremely high. Heavy and bulky machines. Not relevant for this field of robots covered.

↳ Type of generated movement

- Rotary actuator: primary energy is converted to rotating motion which can be continuous, positioned or a source of application of force (torque).

- Linear actuator: converted into linear motion. Can include the direct application of a force, positioning of a mechanical element or execution of a repetitive continuous motion.

→ Rotary Actuators

Most common, use electricity as primary source of energy. (commonly named as 'drivers' or 'motors')

Three types:

- Brushed DC motors
- Brushless DC motors
- Stepper motors

↳ Brushed DC motors

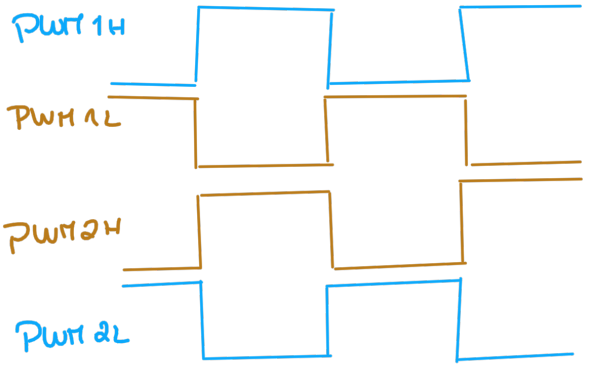
Use DC power to generate rotational motion. Consist of rotor (rotating part, attached to shaft equped with magnets) and stator (contains set of coils powered by direct current).

Current makes the coils create a magnet field, and the interaction of these magnet fields makes the rotor rotate.

Switching the direction of current flow to ensure torque remains in same direction is performed mechanically by the brushes.

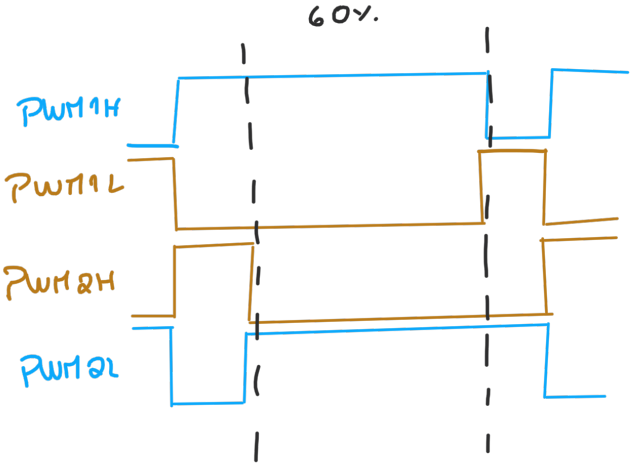
Speed control of DC motors can be done by varying the voltage applied to the terminals. (By a PWM controller).

To change the direction of rotation of a DC motor, the polarity of the applied voltage must be reversed.



STOPED

60%.



RPM ~ 60%.

O PWM 1H e PWM 2H estão ambos fechados e por isso não há diferença de voltagem e portanto não há corrente aplicada.

A mesma coisa com PWM 1L e PWM 2L (os dois switches de baixo).

Neste caso, o duty cycle é de ~ 60% e portanto o motor está a 60% da energia máxima e a rotação é dada pela rotação atribuída ao PWM 1H e PWM 2L, pois são esses dois sinais que estão a 1 nesse intervalo (azuis).

↳ Brushless DC Motors (BLDC)

Use permanent magnets mounted on the motor. The poles are excited by an externally applied voltage.

This configuration eliminates the need for a mechanical switching system (brushes), requiring an electronic control which ensures the correct sequential switching of the poles.

Have greater efficiency and almost no maintenance.

It requires a mechanism to provide information on the absolute position of the motor.

↳ Stepper motors

Magnets and coils. With current, generates a magnetic field which aligns teeth. The teeth of the other coils are slightly out of phase, so when the current switches to other coil, a new binary is generated to trigger a new alignment.

→ Comparison of these three types

Brushed DC	Brushless DC	Stepper Motors
+ cheap	- price	-- price
- efficiency	+ efficiency	-- efficiency
- power vs volume	+ power vs volume	+ very precise
+ simple startup	- complex startup	+- complex
	+ good for planar topologies	+ good for planar topologies
+ simple control	- complex control	+- control
- mechanical wear-out	+ maintenance	- mechanical vibration
+ power range	+ range of not-speeds	+ positioning apps.

→ Solenoids

Converts eletrical energy into linear motion. Uses coils and magnetic fields (used in valves, actuators, locks, relays).

→ Servo motors

Combination of BLDC, reduction gearbox and eletronic control loop.

Good for angular positioning which require good accuracy.