ME729 Advanced Robotics - Actuators and Sensors

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Actuators

❑ DC and BLDC Motors

- In robotics as well as control field, DC motors are used for incremental motion servo systems.
- The function of the motor in serving as the actuating component for the system is to provide the torque needed to accomplish the system's incremental motion demands.
- To make reliability increase, brushless DC (BLDC) motors are applied to the actuators.
- The BLDC motors are a special class which uses the same technology as the brush-type DC motors.
- But the BLDC motors' commutation is performed by electronic rather than mechanical means.

Actuators

- DC Motors
  - From YouTube : https://youtu.be/LAtPHANEfQo

Actuators

- BLDC Motors
  - From YouTube : https://youtu.be/bCEiOnuODac

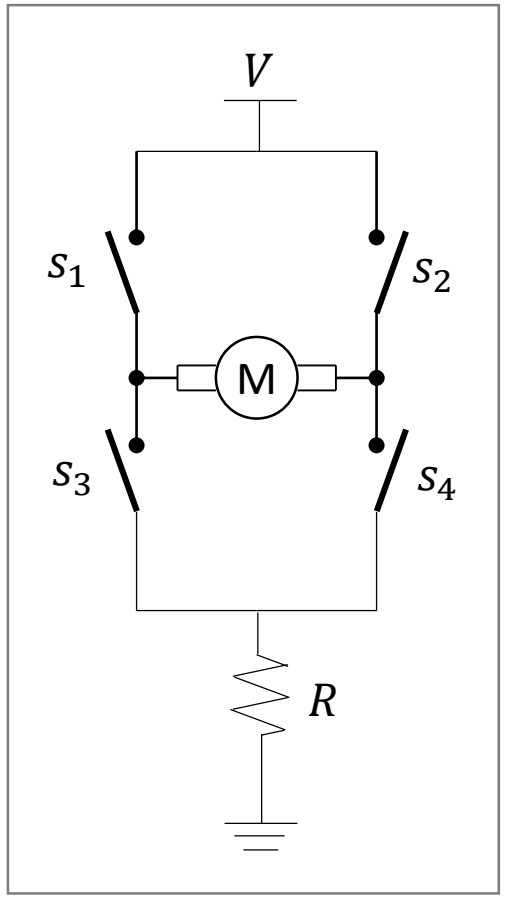
Actuators

- Comparison with DC and BLDC motors

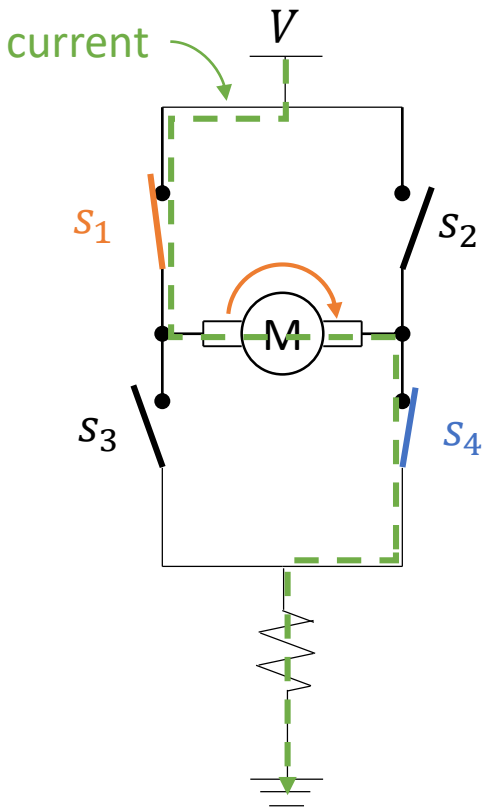
DC motors	BLDC motors
It uses brushed commutation.	It uses electronic commutation based on hall position sensors because of no brushes.
It requires periodic maintenance.	It requires less maintenance due to the absence of the brushes.
It has shorter life.	It has longer life.
It has moderate efficiency.	It has higher efficiency. Hence, there is no voltage drop across brushes.
Rotor inertia is higher.	Rotor inertia is low. Because it has permanent magnets on the rotor.
The speed range is lower.	The speed range is higher.
The cost of building is lower.	The cost of building is higher.
Motor control is simple and inexpensive.	Motor control is complex and expensive.

Actuators

- DC motor inverter configuration
  - The schematic

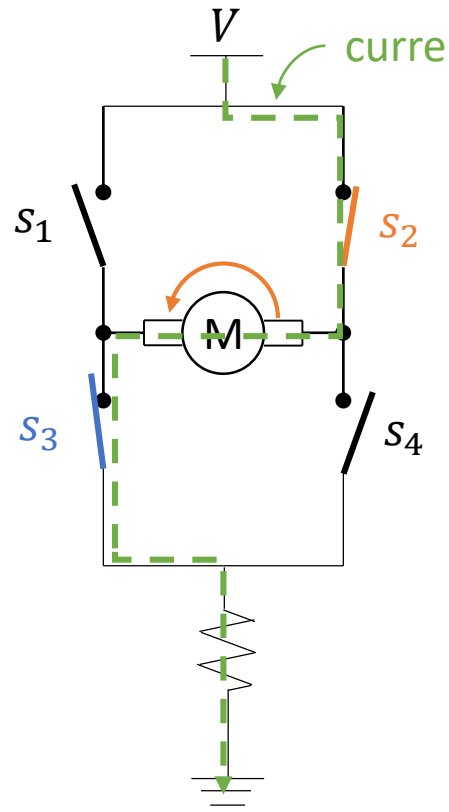


[Clock-Wise rotation]



s_1	On
s_2	Off
s_3	Off
s_4	On

[Counter Clock-Wise rotation]



s_1	Off
s_2	On
s_3	On
s_4	Off

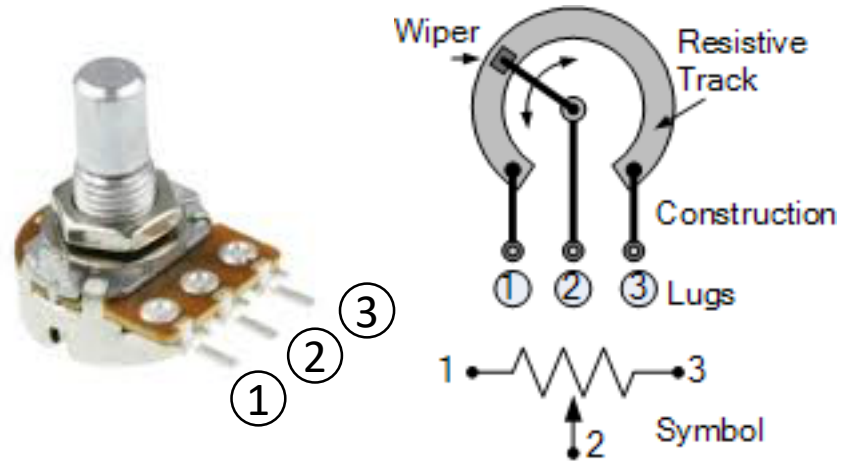
Sensors

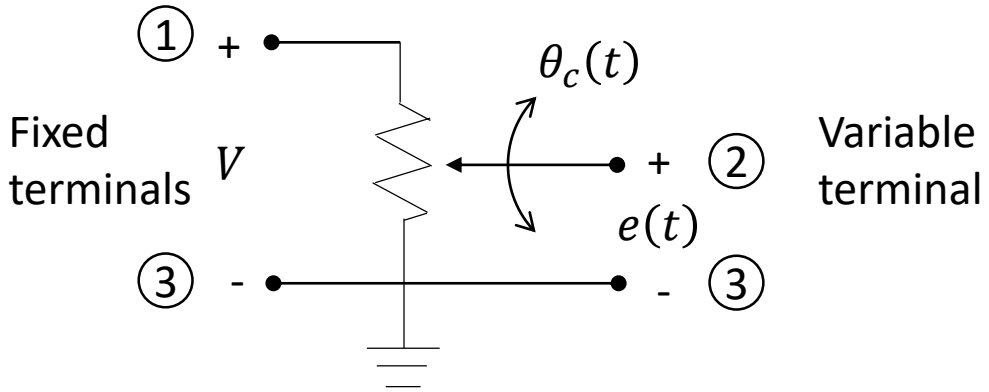
❑ Potentiometers

- Potentiometers are used to measure linear or rotational displacement.
- When a voltage is applied across the fixed terminals of the potentiometer, the output voltage across the variable terminal and reference is proportional to the shaft displacement of it.
- The input voltage V, the output voltage $e(t)$, the shaft position $\theta_c(t)$, a proportional constant K_s and for an N-turn potentiometer,

$$e(t) = K_s\theta_c(t)$$

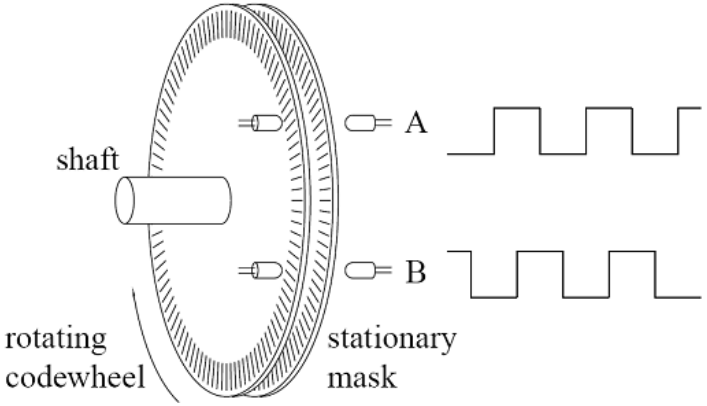
$$K_s = V/2\pi N \quad \text{volts/rad}$$





Sensors

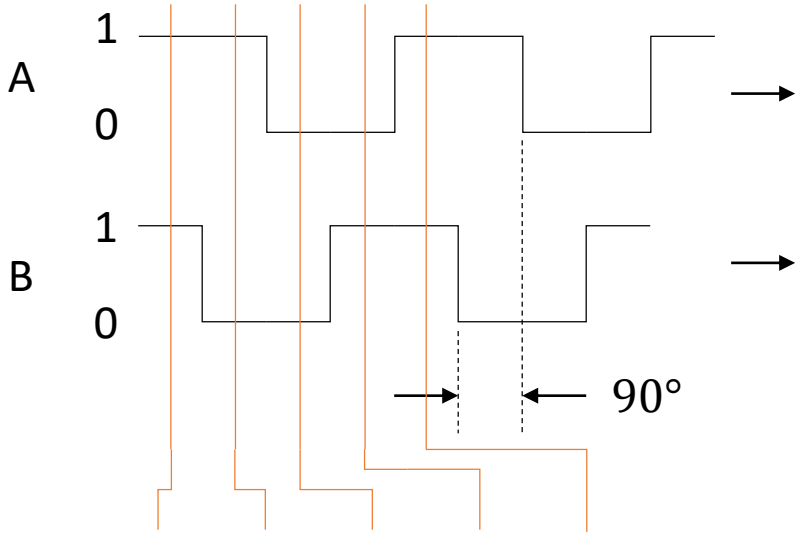
- Rotary incremental encoders
  - The rotary incremental encoders are defined as a device which produces electrical pulses at equal angular increments of shaft displacement.
  - Most rotary encoders are composed of a glass or plastic slotted disk.
  - As radial lines in each track interrupt the beam between a photoemitter-detector pair, digital pulses are produced.



Sensors

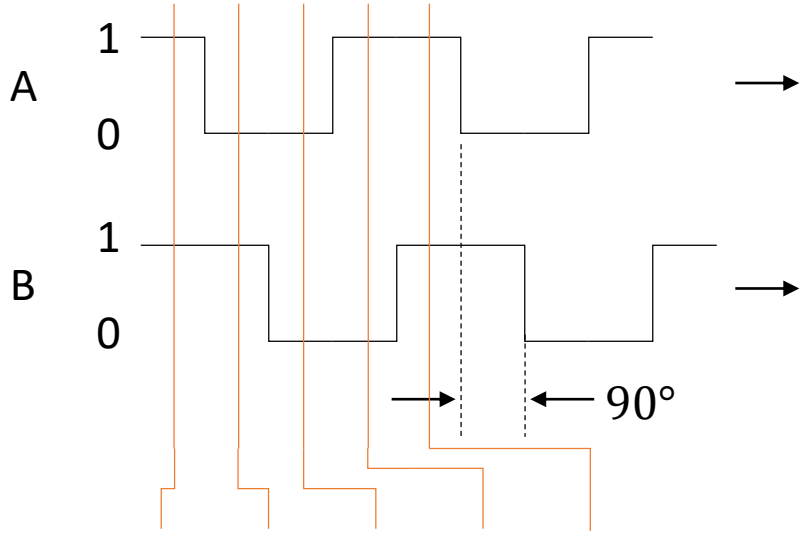
- Rotary incremental encoders - continued
  - A dual-channel encoder with two sets of output pulses is necessary for direction sensing.
  - There is a phase difference of $90°$ between two output pulses.
  - When the phasing of the two output pulse trains is $90°$ apart electrically, the two signals are said to be in quadrature.

CW shaft rotation



(A,B)= (1,1) (1,0) (0,0) (0,1) (1,1) …

CCW shaft rotation



(A,B)= (1,1) (0,1) (0,0) (1,0) (1,1) …