Electronics for IoT

DC Motor

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Types of Motors

- Many
- DC Motor
DC Motors
DC Motor Applications

- Electric active stabilizer motor
- Electric oil pump
- Headlight optical axis drive motor
- Electric parking brake motor
- Electric power steering motor
- Automatic hatch open/close motor
- Door lock motor
- Door open/close motor
- Seat cooling fan motor
DC Motor Applications
Torque
Lorentz Force
Electrical Motor Principle (1)

When electric current passes through a coil in a magnetic field, the magnetic force produces a torque which turns the DC motor.

Electric current supplied externally through a commutator.

https://www.pc-control.co.uk/dc-motors.htm
Electrical Motor Principle (2)

When electric current passes through a coil in a magnetic field, the magnetic force produces a torque which turns the DC motor.

Magnetic force $F = I \cdot L \cdot B$ acts perpendicular to both wire and magnetic field.

https://www.pc-control.co.uk/dc-motors.htm
Electrical Motor Principle (3)

When electric current passes through a coil in a magnetic field, the magnetic force produces a torque which turns the DC motor.

Torque = force \times \text{lever arm} = (ILB) \left(\frac{W}{2}\right) \sin \theta \times 2 \text{ sides} = ILBW \sin \theta = IBA \sin \theta

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Electrical Motor Principle (4)

When electric current passes through a coil in a magnetic field, the magnetic force produces a torque which turns the DC motor.

Electric current supplied externally through a commutator.

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Practical Motor

Typical Brushed Motor in Cross-section

- Rotor
- Commutator
- Brushes
- Magnet
- Windings
- Stator (case)
- Terminals
DC Motor

- Wiring box
- Deep groove ball bearing
- Ventilation slots
- Stator with windings
- Rotor with windings
- Brushes
- Seal
- Output shaft
- Mount feet
Winding
Commutator
Motor Nomenclature

Ref: Motors for Makers, Matthew Scarpino
I, V, τ, ω
Power
RPM vs rad/s
Motor I, V, $\tau$, $\omega$
\( \tau \text{ VS } \omega \)
Power vs $\omega$
Gear Motors
Speed Control

Motor RPM versus Voltage (no load)

Voltage [V]

RPM

Current [mA]

RPM / Current [mA]

Voltage [V]

IoT49: DC Motor
Summary

• Current flow →
  – Lorentz Force
  – Magnetic Field

• DC motor
  – Mechanical power == Electrical Power
    • (Minus loss)
    – $\tau \omega = IV$
  – Maximum torque at $\omega = 0$