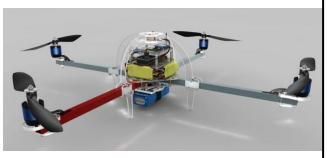
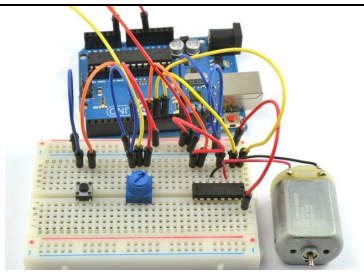
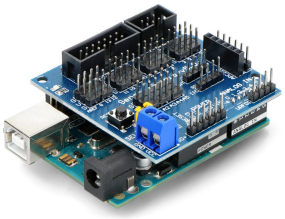
Do Now

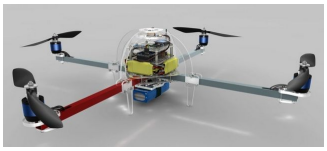


What is the role of a magnet in a motor?





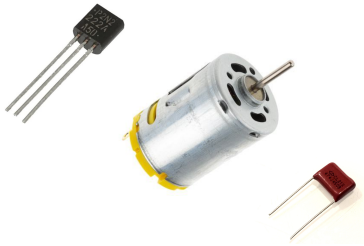
Intro to Digital Motors



Yesterday we explored basic motors, which can be hooked up directly to a power source. Today we are going to introduce digital motors– motors that are controlled by a digital device such as an Arduino. Using a digital device allows for much more specific behavior, such as programming a motor to spin exactly 12 degrees.

Goals

- Discuss how basic commercial motors work
- Identify 3 common types of motors
- Identify and justify which type of motor to use in different scenarios

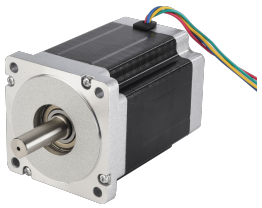


Motors

- Devices that convert electrical energy into rotational kinetic energy

Basic DC Motors

Servo Motors



Stepper Motors

3 types of motors that we will use with the Arduino

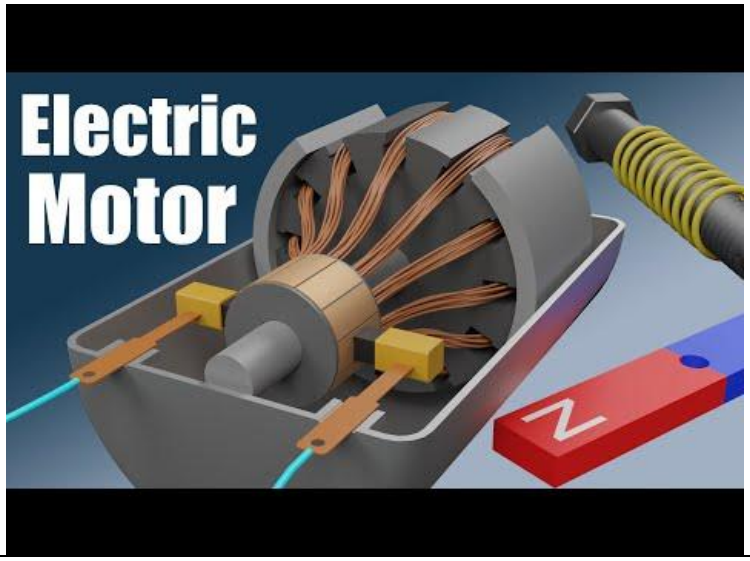
Standard DC Hobby Motors

- Can spin CW or CCW
- Crude: either on or off
  - Speed determined by voltage
  - Direction determined by polarity of current
- Unlimited rotation in one direction
- What are some devices that could use hobby motors?

gearbox motor

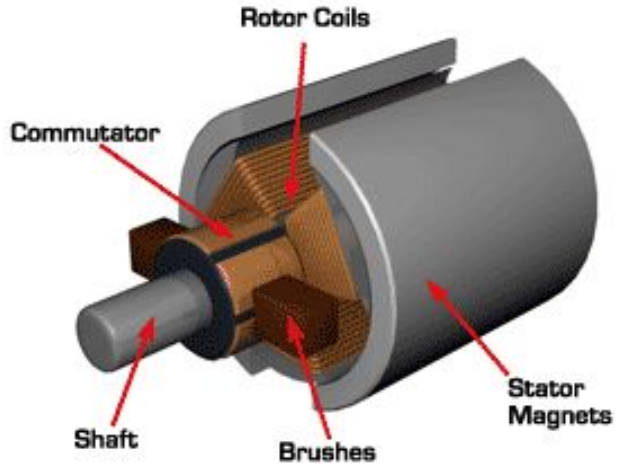
Often used with vehicles or fans

Basic Motors Video



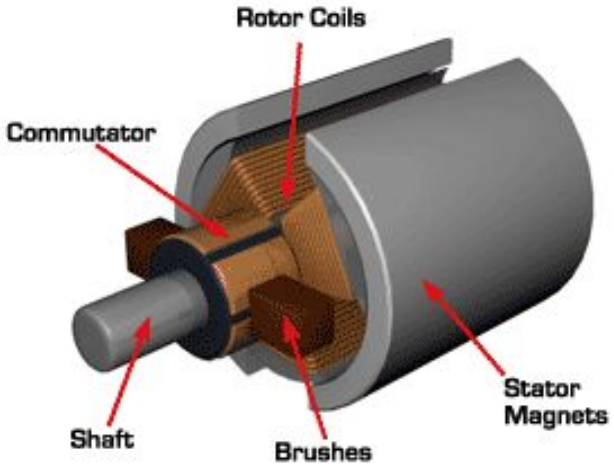
Start video at 2:27

What's Inside a DC Hobby Motor?



The wires coming out of the motor connect to the brushes, which connect to the commutator, which connects to the coils. As electricity passes through the coils, it generates a magnetic field. The coils then are attracted to the magnet, causing them to turn. As it spins, the brushes connect to different parts of the commutator, magnetizing different coils of wire so that the rotor keeps spinning in the same direction. This coils are attached to the shaft, so this causes the shaft to spin. This is a brushed motor. Brushless motors work differently. If the polarity of the electricity is reversed, the motor will spin in the opposite direction.

What's Inside a DC Hobby Motor?



How is this design an improvement on the basic motors we built yesterday?

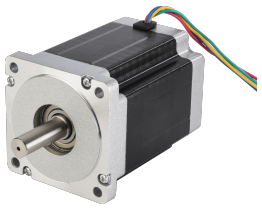
Our basic motors had no current (and thus no torque) half the time, relying on momentum to carry them through. The brushes and commutator allow the motor to always have coils that are magnetized, but simply rotate *which* coils are magnetizing, producing a more constant torque. Also the magnet surrounds the coils rather than just sitting on one side.

Motors

- Devices that convert electrical energy into rotational kinetic energy

Basic DC Motors

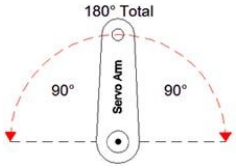
Servo Motors



Stepper Motors

Standard Servos

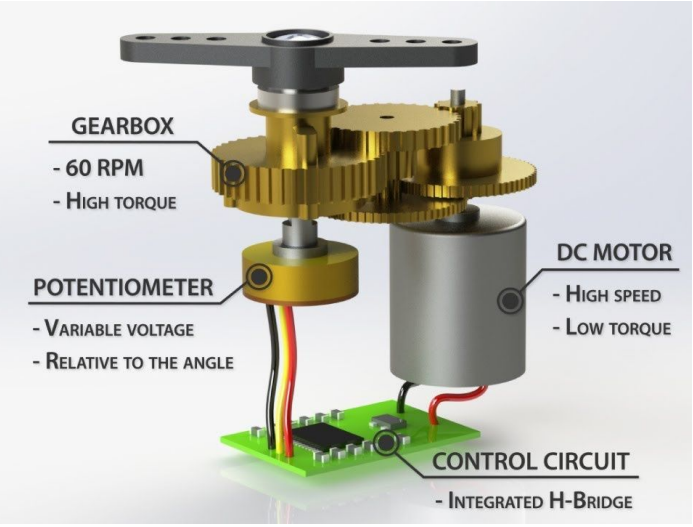
- Precise: Can rotate to a specific angle
- Limited rotation
  - often 180°
- High torque at high speeds
- Good for back and forth, open and closed, dials
- What are some devices that could use servo motors?



Robotic arms, windshield wipers, factory equipment, camera lenses, DVD players (to extend/retract the disk tray)

Other advantages: More power efficient than stepper motors
Other disadvantages: more expensive

What's Inside a Servo?



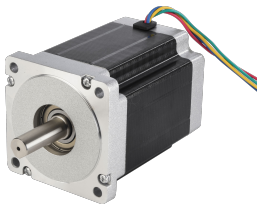
Chip controls the DC motor, turning it on until the motor has rotated the correct amount and then turning it off.

Motors

- Devices that convert electrical energy into rotational kinetic energy

Basic DC Motors

Servo Motors



Stepper Motors

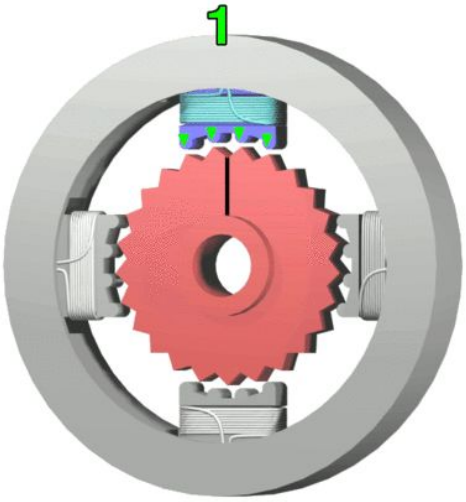
Standard Stepper Motors

- Precise: Can program to rotate to a specific angle or step
- Unlimited rotation in either direction
- High torque at low speeds
- What are some devices that could use stepper motors?

3d printers, printing presses, analog clocks, feed mechanisms for ATMs and metrocard machines. Note that stepper motors have poor performance at high speeds.

Other disadvantages is that they are often noisy and less energy efficient than servos.

What's Inside a Stepper Motor?



Stepper motor driver chip controls which of the 4 electromagnets is magnetized at any given moment. In the center is a permanent magnet which has gear teeth that align to one of the 4 electromagnets. As the electromagnets are magnetized, the rotor will spin to align its teeth with the magnet, spinning ¼ of one tooth. This allows for extremely accurate rotational angles.

For more, check out this video:
https://www.youtube.com/watch?v=eyqwLiowZiU

Motor Applications

With your partner, determine which type of motor you would use for each device and explain your reasoning

1. Automatic doors
2. Laptop fan
3. Elevator
4. Escalator
5. Electric toothbrush
6. Grocery store conveyor belt