

# Basics of Designing


# Intended Purpose



# Parameters

- Steering mechanism
- Wheel
- Material
- Center of gravity (CG)
- Power source (mainly batteries)
- Motors

# Types of Steering Mechanisms

- Differential
  - Axial
  - Rack and pinion
- 
- Efficient With analog  
Control Circuit

# Differential Steering Mechanism

- Mechanism in which movement is based on two (or set of two) separately driven wheels placed on either side of the body so that it can change its direction by varying the relative rate of rotation of its wheels.

## ➤ Advantages

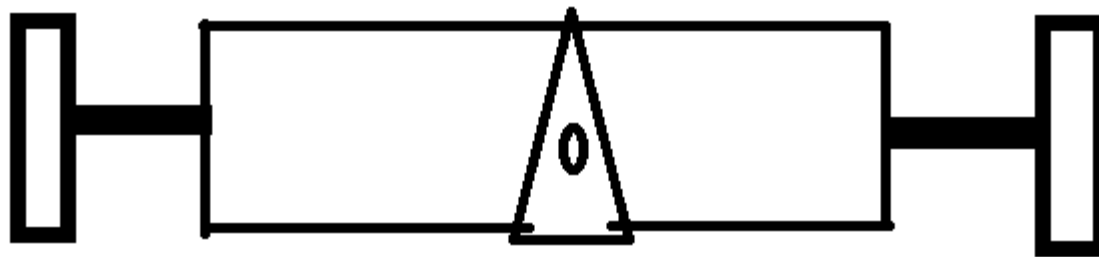
- Easy to implement and actuate
- Involves very less mechanical interactions hence very reliable

## ➤ Disadvantages

- Robot can not move in straight line for long time
- Calculated turns cannot be taken

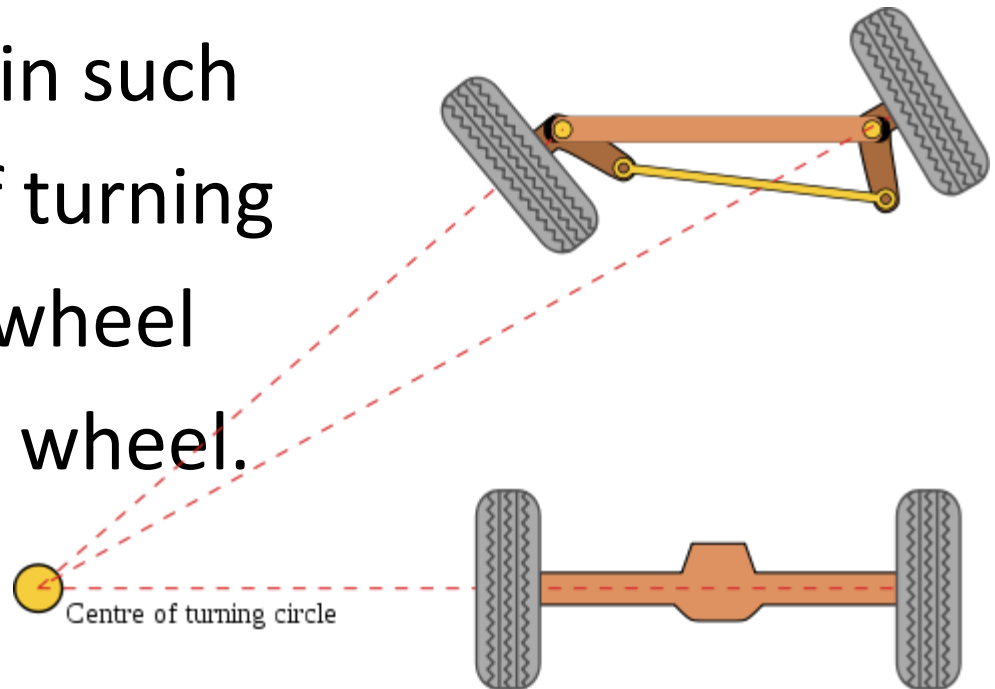
# Axial Steering Mechanism

- Mechanism in which the actuator is directly coupled to the axis connecting the two wheels there by causing lateral movement by directly rotating the axis



# Rack and Pinion steering mechanism

- Ensure that the wheels are pointing in the desired directions. This is typically achieved by a series of linkages, rods, pivots and gears.
- Wheels are aligned in such a way that radius of turning is smaller for inner wheel and larger for outer wheel.





# Definition of rack and pinion

- A **rack and pinion** is a type of linear actuator that comprises a pair of gears which convert rotational motion into linear motion. A circular gear called "the pinion" engages teeth on a linear "gear" bar called "the rack"; rotational motion applied to the pinion causes the rack to move, thereby translating the rotational motion of the pinion into the linear motion of the rack.



# Mechanism

- In rack and pinion steering mechanism the steering motor turns the pinion gear; the pinion moves the rack, which is a linear gear that meshes with the pinion, converting circular motion into linear motion along the transverse axis of the robot (side to side motion).

## ➤ Advantages

- Calculated turnings can be taken easily
- Robot can move in straight line for longer distances

## ➤ Disadvantages

- Difficult to implement
- Involves greater mechanical interactions: liable to fail

# Wheels

- No of wheels
- Size of the wheels

# No of wheels

- Four wheel drive
- Three wheel drive
- Two wheel drive
- One wheel drive ?????

# Four wheel drive

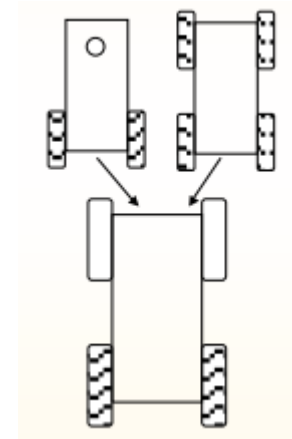
- More no of motors more torque
- Easy to climb inclined plane
- If not aligned properly : 1 motor useless
- Different RPM : Power loss

# Three wheel drive

- Minimum no of points to form a plane
  - Wheels always in contact
- 
- Only 2 motors
  - Wheelie can occur at the start of motion

# Remove grip of front wheels ?

- Easily rotated than 4 wheel drive
- More torque than 3 wheel drive





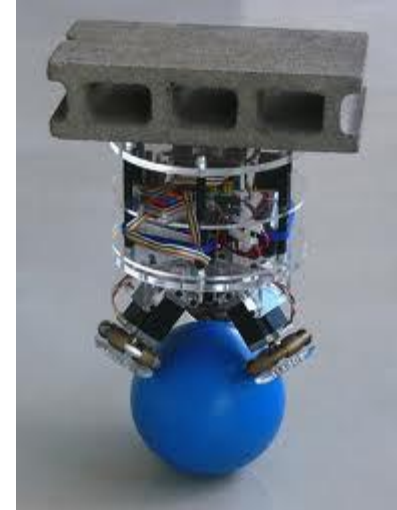
# Two wheel drive

- Segway



# One wheel drive

- One wheel balancing robot



# Size and Strength

- Diameter
  - Large : positioning less accurate\*
- Task



# Continued...

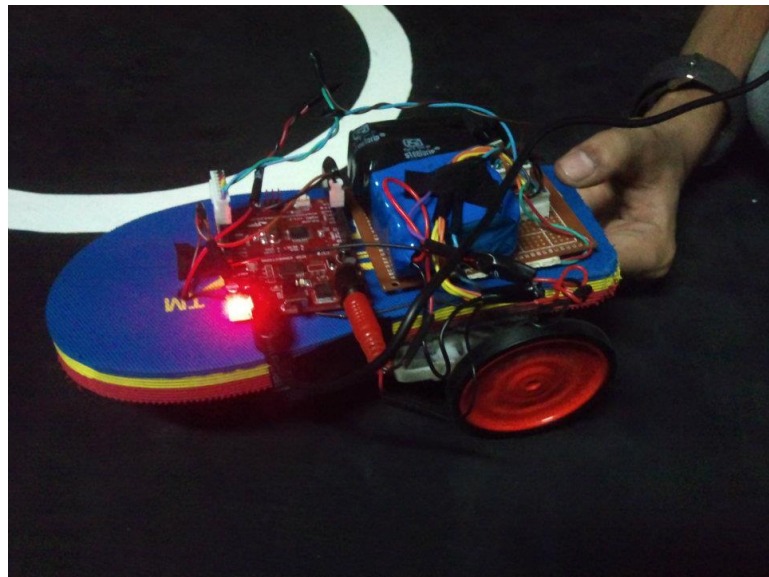
- Given a motor of torque  $\tau$ 
  - High force requirement
    - small diameter
    - opposing torque produce by friction reduces  $\tau(\text{friction}) = R * F(\text{friction})$
  - High speed requirement
    - Large diameter
    - $V = R * \omega$

# Material for chassis

- Acrylic
- Aluminum
- Wood

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# Acrylic

## ➤ Advantages

- Light weight
- Easy milling
- Transparent acrylic sheets can be used in the robots in which internal mechanisms need to be presented

## ➤ Disadvantage

- Very brittle and fragile
- Is not reliable for long term usage of the machine

# Aluminum

## ➤ Advantage

- Light weight
- Easy milling (compared to other metals)
- Readymade sections, bars, boxes etc are easily available in the market which can be directly used
- More strength to weight ratio

## ➤ Disadvantage

- Sheet of same dimension is very heavy as compared to rest of the two materials

# Wood

## ➤ Advantages

- Lightest among the three
- Relatively cheaper than acrylic

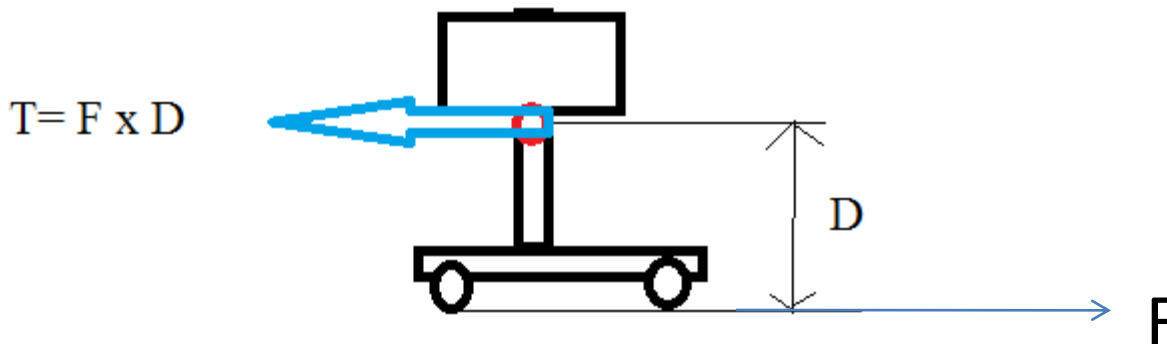
## ➤ Disadvantages

- Very weak
- Not Waterproof



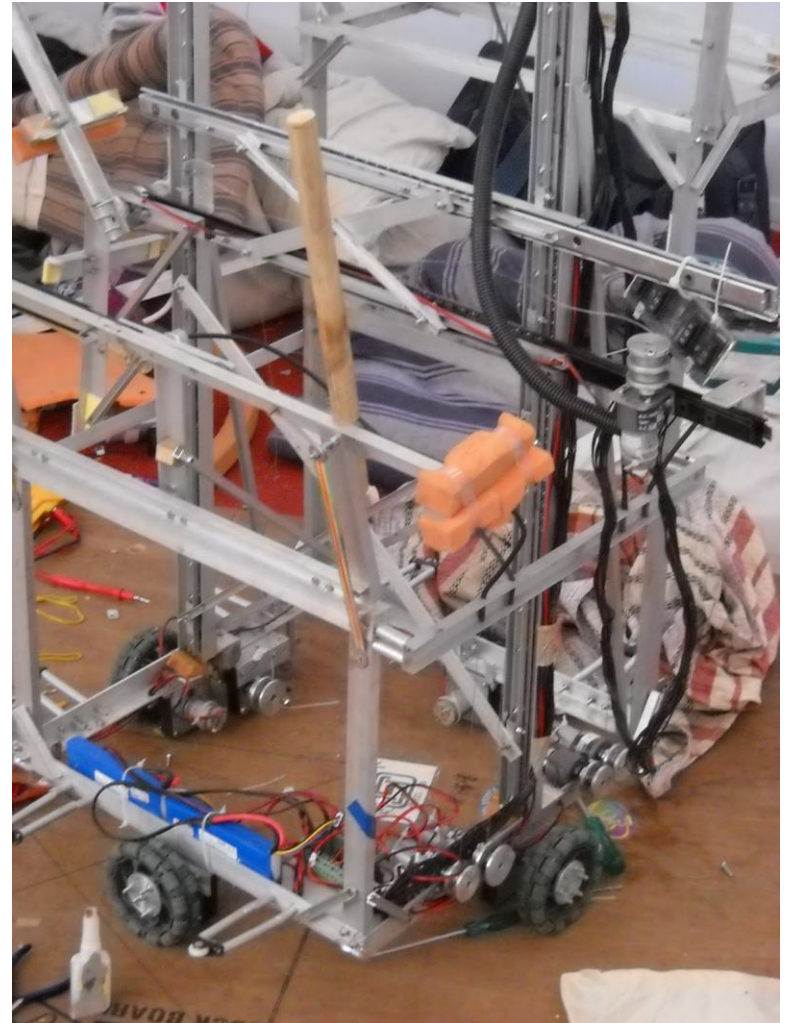
# Center of Gravity

- Low
- Stability ↑
- Impulsive force & at start of motion



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- D ↓ T ↓ Toppling ✕
- Close to the wheels having grip
- Gripper motor positioning
  - Brake wire (Cycle)
  - Use Pulley - Rope System



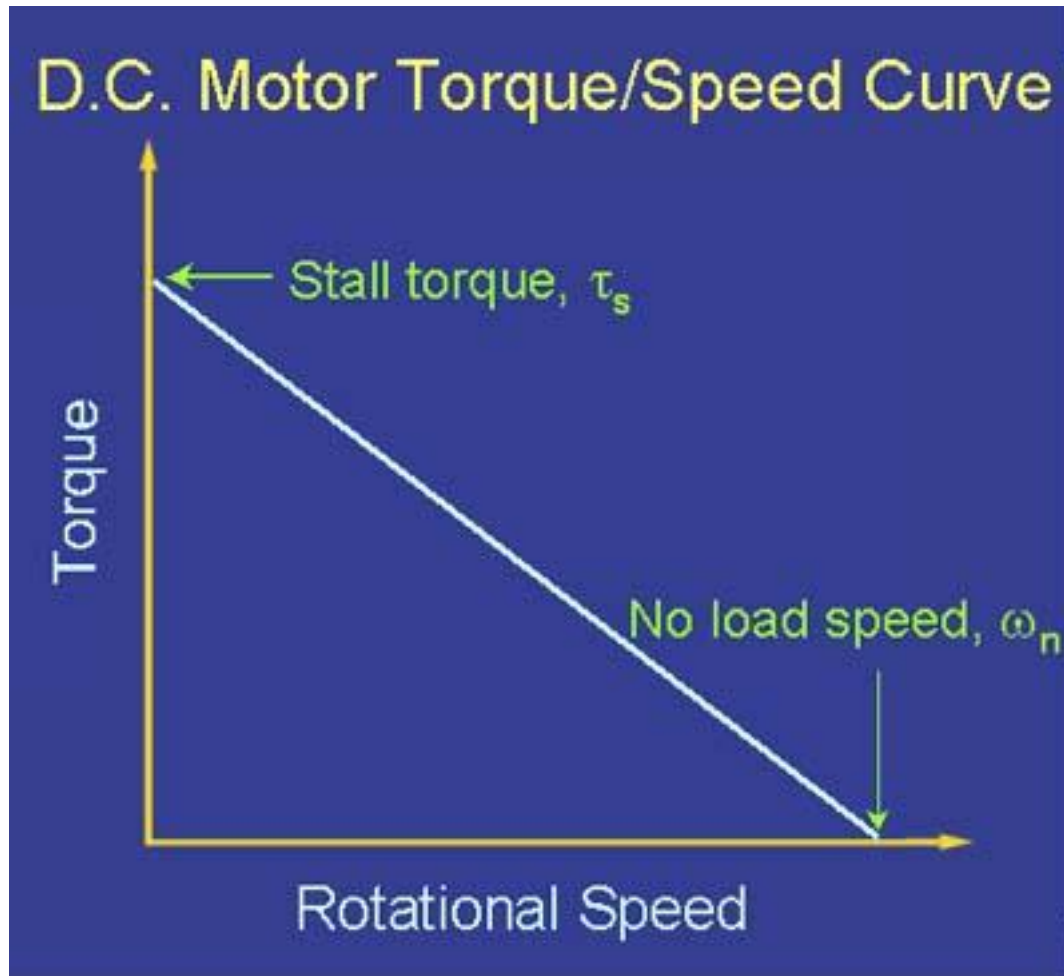
# DC Motors

- DC motors
- Stepper motors
- Servo motors

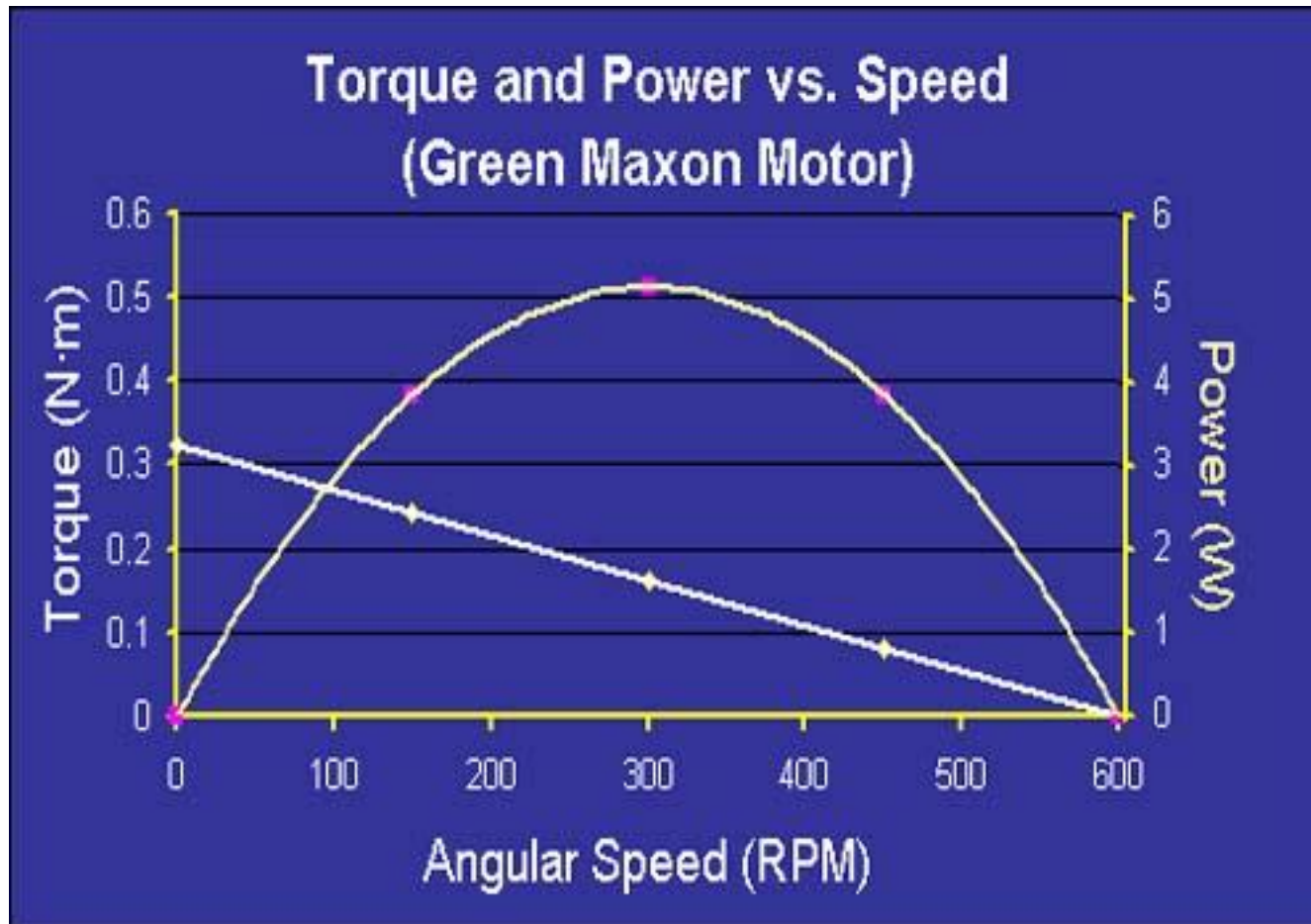
# Selection

- Type of motor : application requirements
  - Speed of robot
  - Weight
  - Accuracy of position
- Parameters
  - Rated Speed
  - Torque
  - Torque-Speed performance

# Characteristic Curves

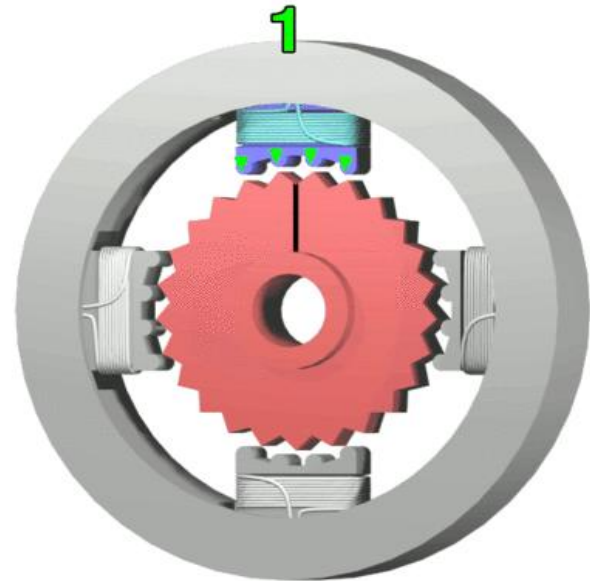


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# Stepper Motor

- Full rotation is divided into large no of steps
- Position can be controlled precisely without any feedback loop



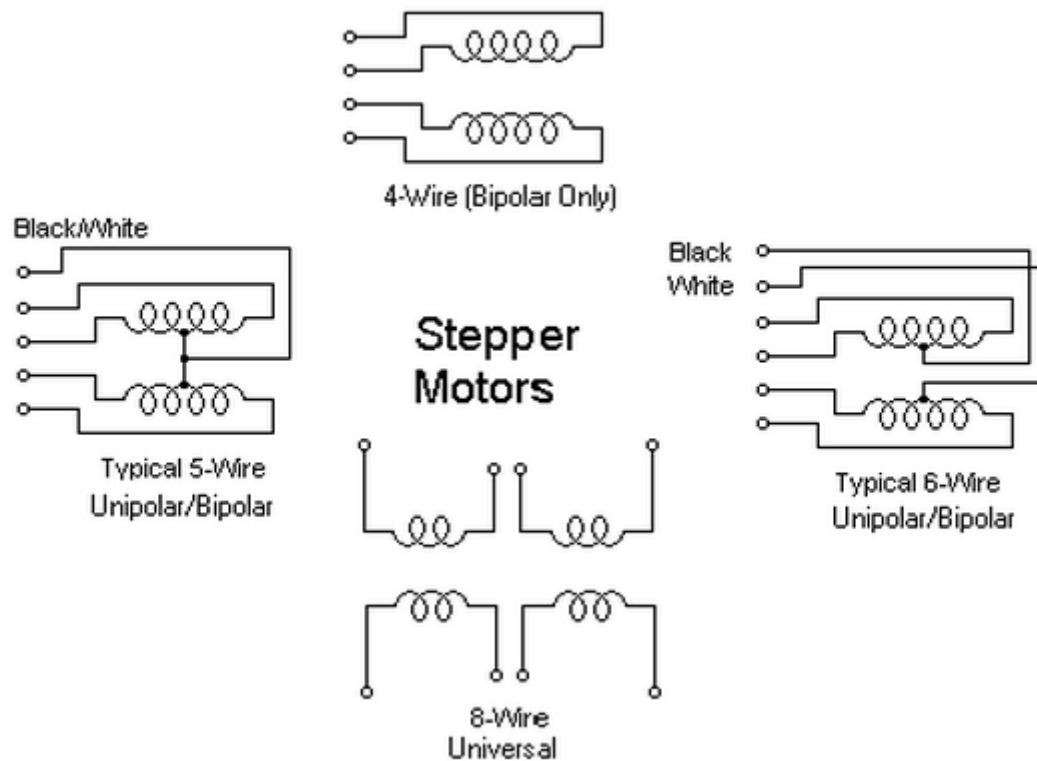
# Servo Motor

- Used in closed loop control systems
- Feedback devices provide position of motor
- Motion profile : a set of instructions programmed into the controller that defines the servo motor operation in terms of time and position





# Unipolar / Bipolar



Thank You