Electrical Training

Week 2: Motors and Controls

Agenda

- Background
- Types of Motors
- Controlling Motors
- Lab

Background

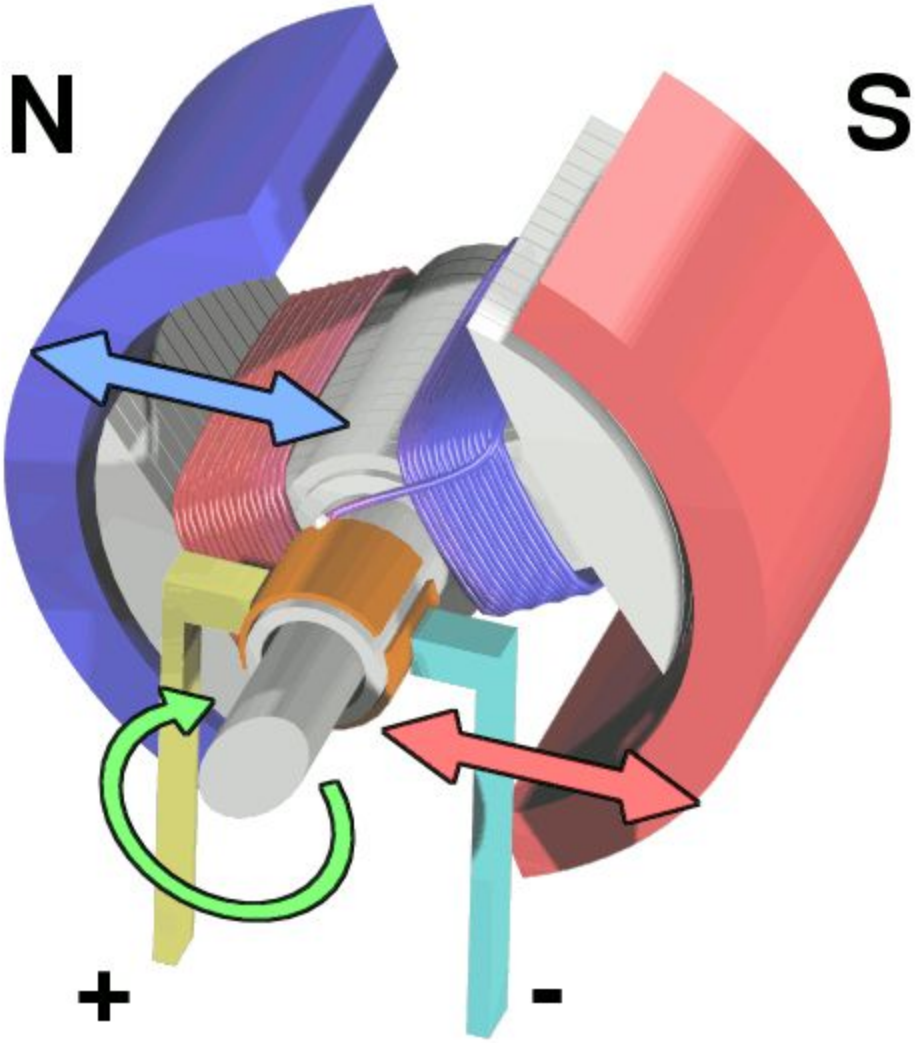
Background

- Software vs Electrical Teams
  - Software: Intelligence/Perception
  - Electrical: Sensing/Control
- Control: Ensuring that robot follows commands accurately
  - Precise motion of motors

Types of Motors

Brushed Motor

- Also known as DC Motors
- Electromagnets attached to axle
- Permanent magnets attached to body
- Current moves from battery to rotating coils through brush
- Switching polarity switches direction of rotation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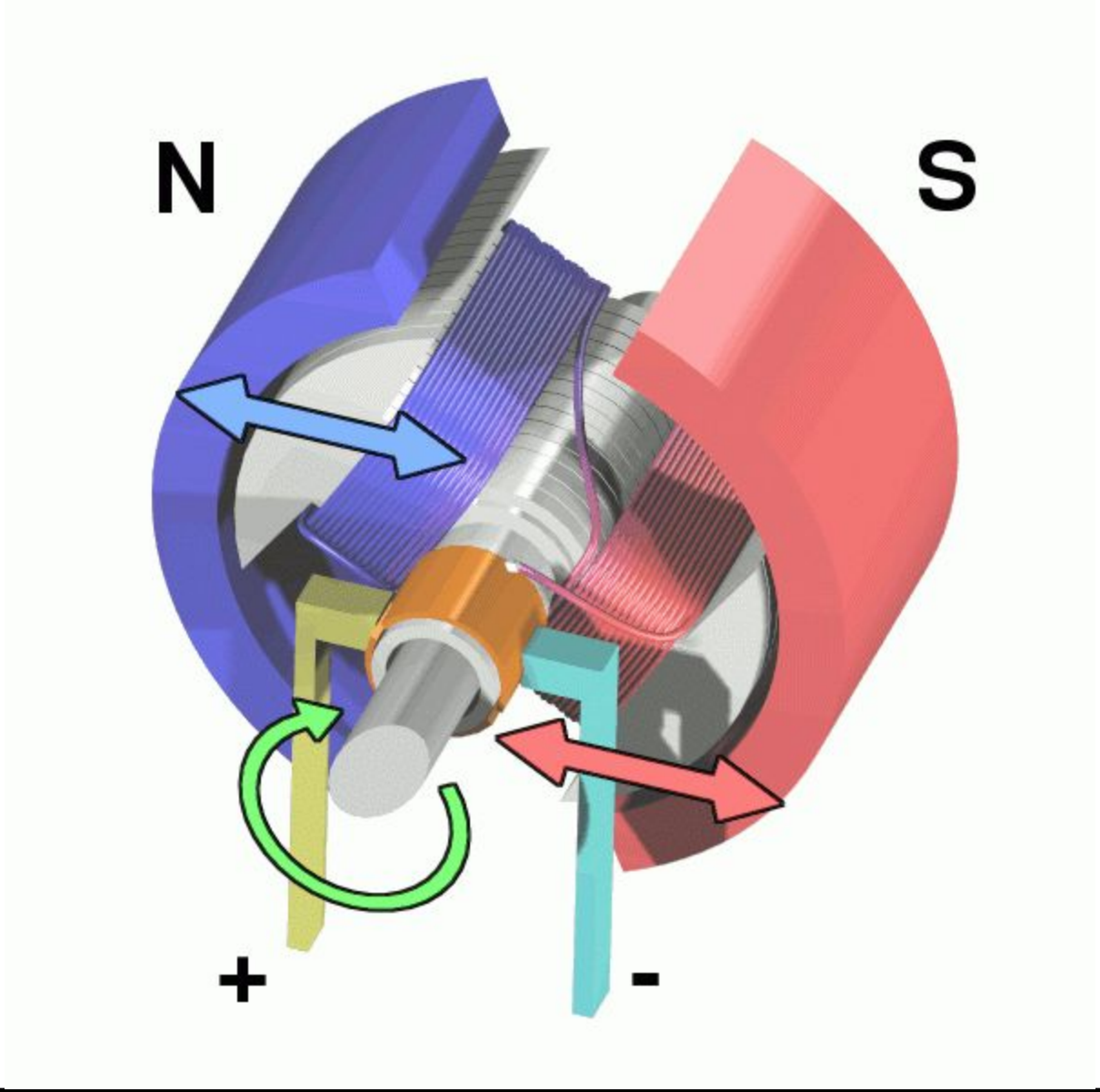
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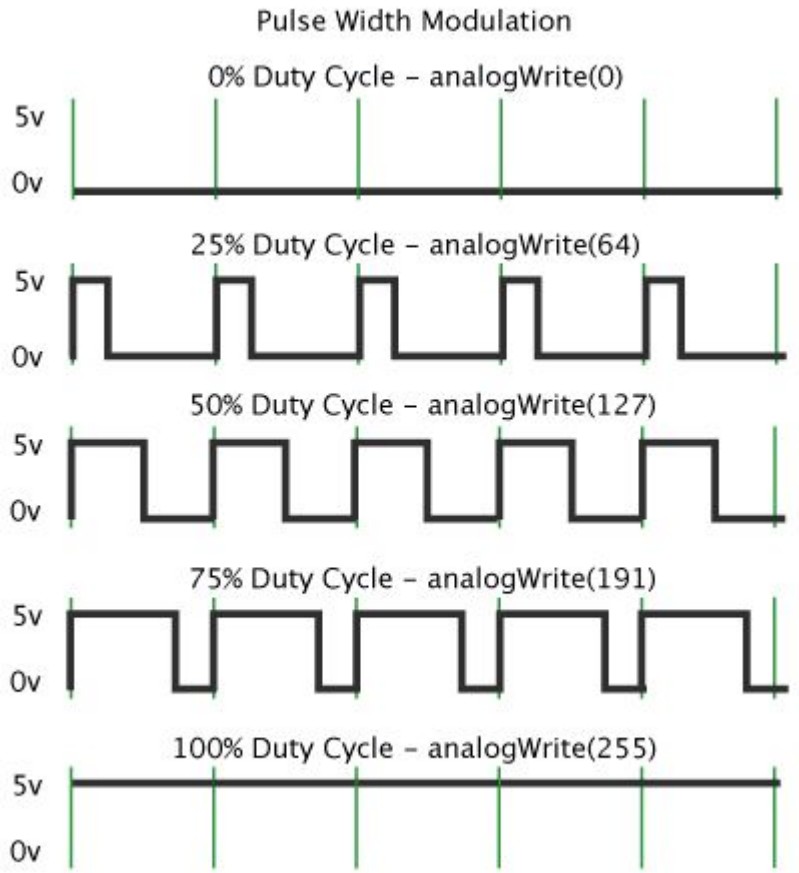
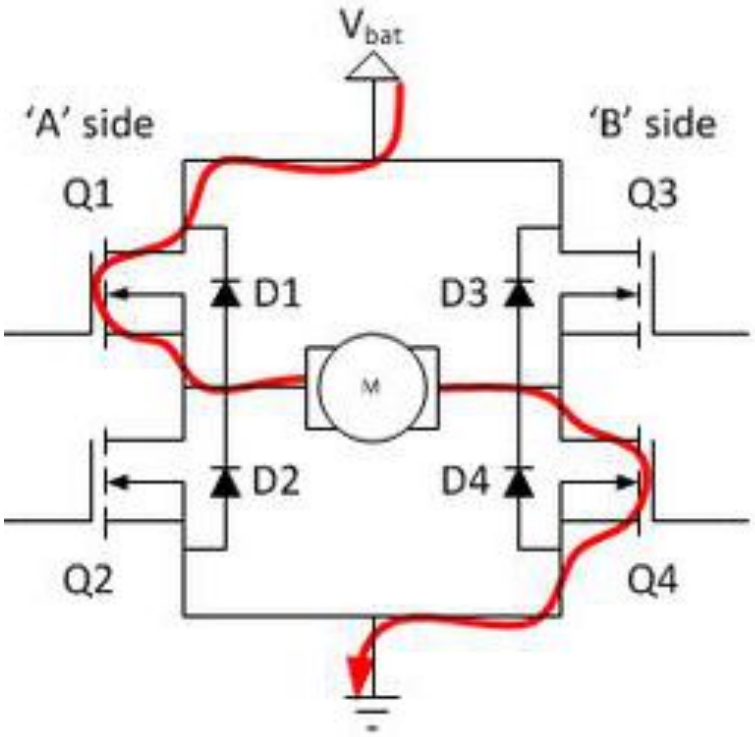
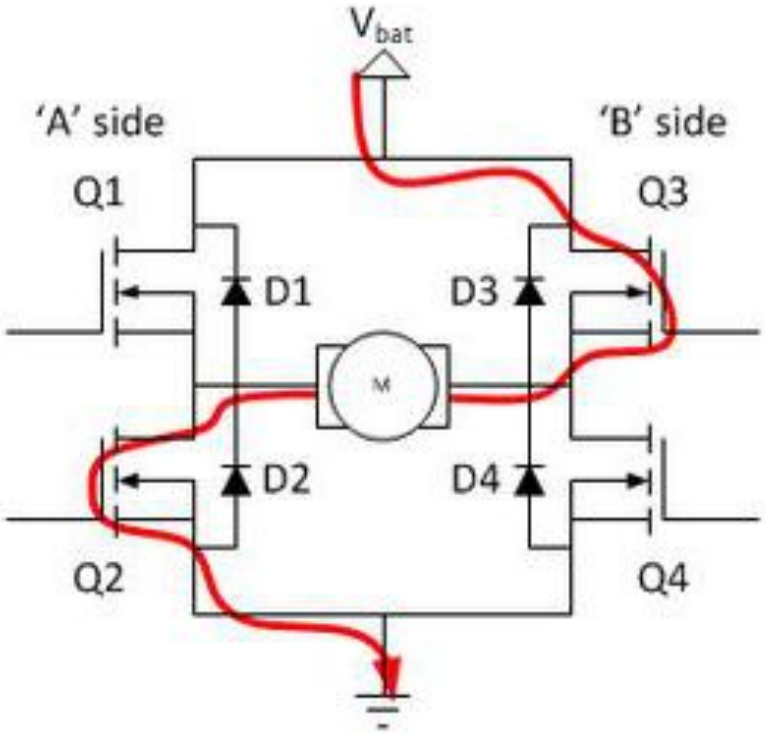
Controlling a BDC Motor

- Speed
  - Controlled by voltage across the brushes - PWM
- Torque
  - Related to current drawn by motor
  - Can not be directly controlled



H-Bridge

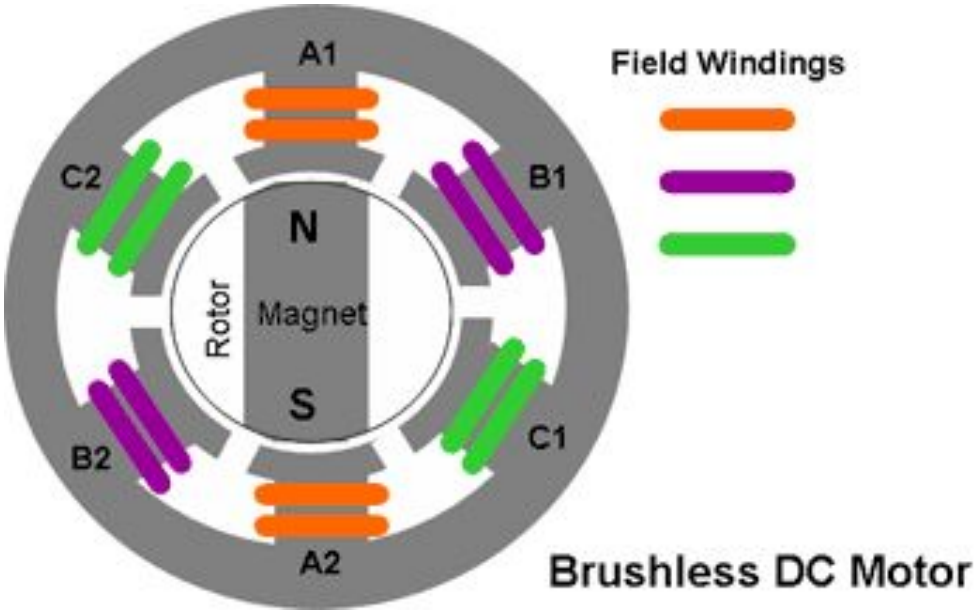

V_{bat}
'A' side
'B' side
Q1
Q3
D1
D3
M
D2
D4
Q2
Q4

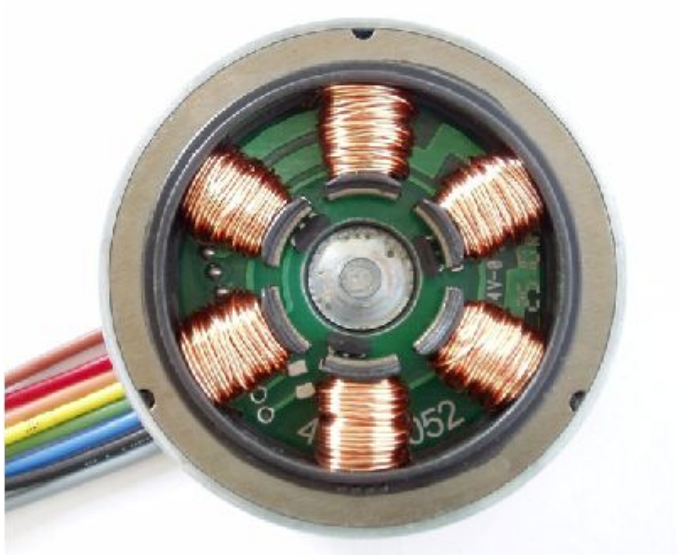

V_{bat}
'A' side
'B' side
Q1
Q3
D1
D3
M
D2
D4
Q2
Q4

Brushless Motor

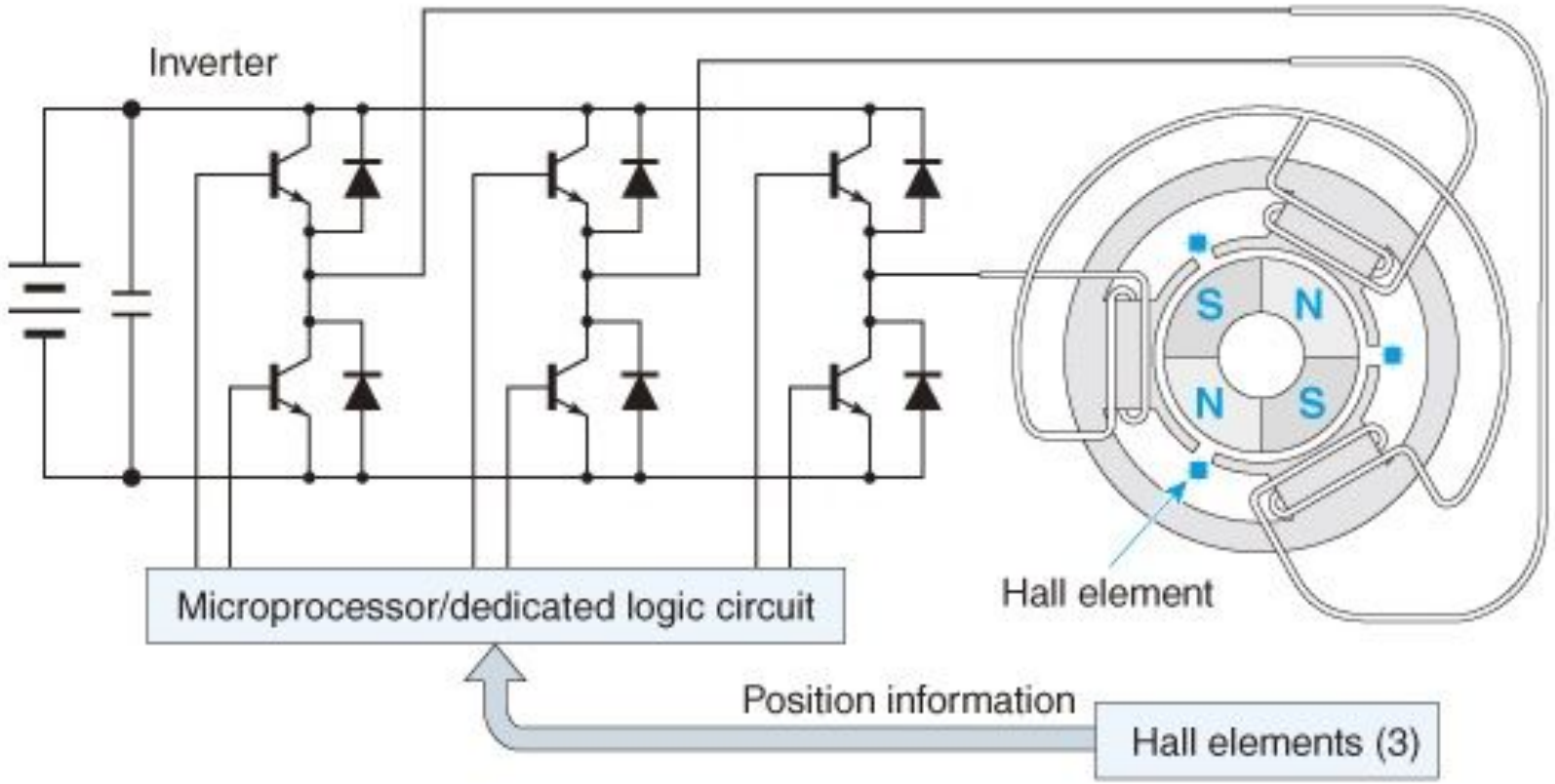
- Also known as AC or 3-phase motor
- Permanent magnet on rotor
- Array of electromagnetic coils on stator
- No commutator
- Switching any two phases reverses direction
- Speed is controlled by frequency of each phase

Brushless Motor

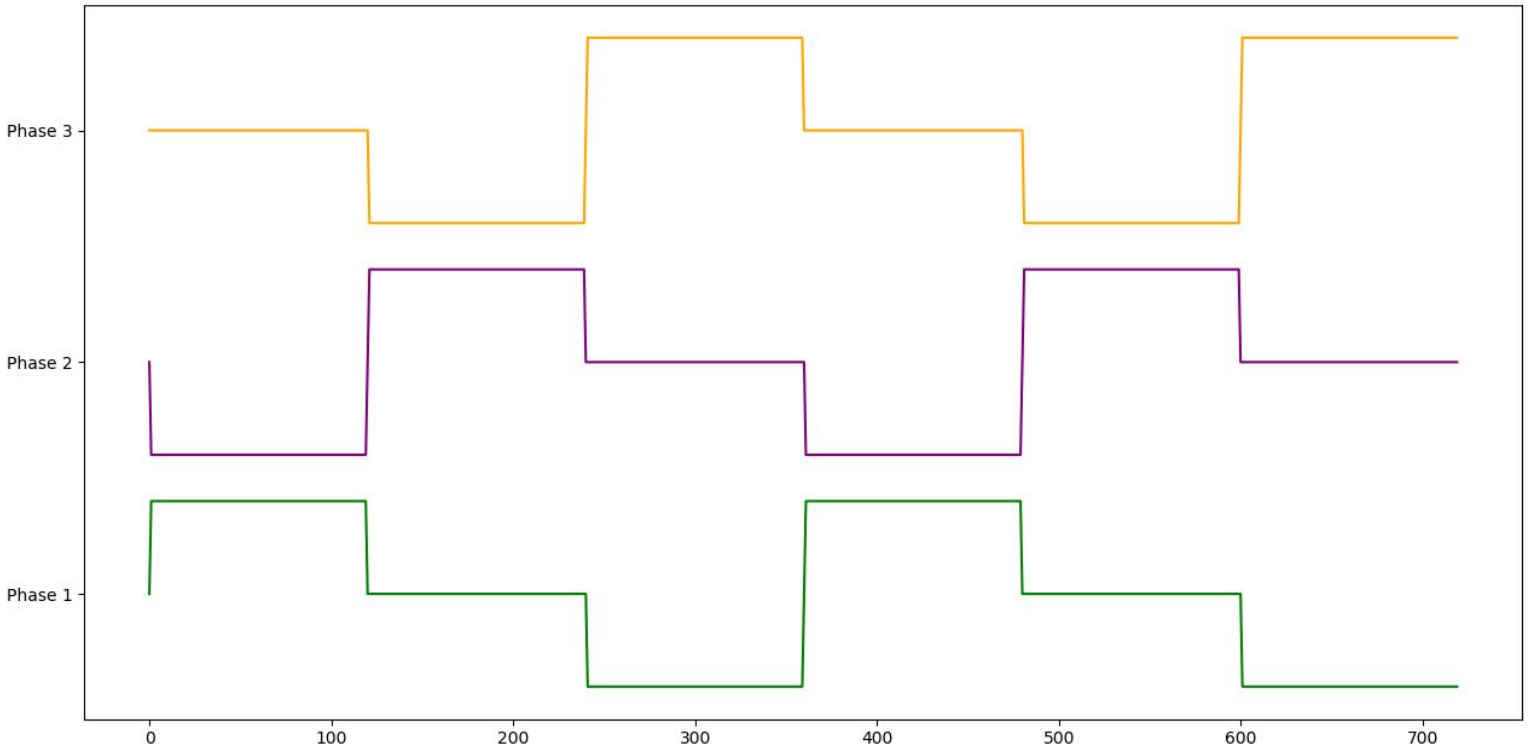




Closed-loop control



Timing Diagram



Conclusion

Brushed DC Motor

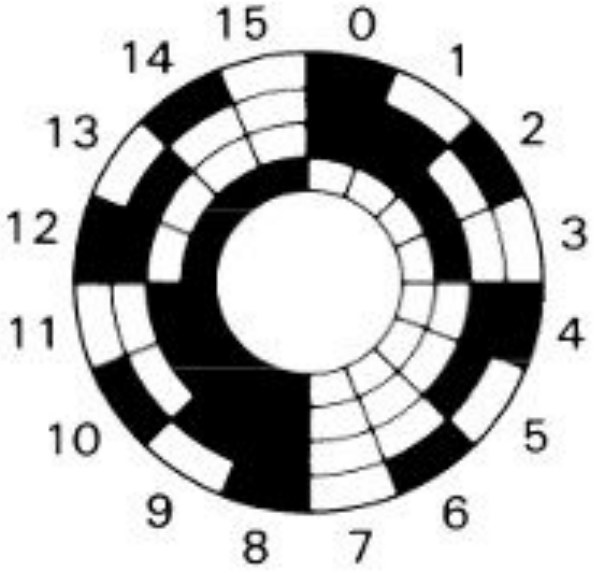
- Uses commutators and brushes to transmit energy
- Friction in brushes leads to more wear over time
- Cheaper
- Easier to actuate

Brushless DC Motor

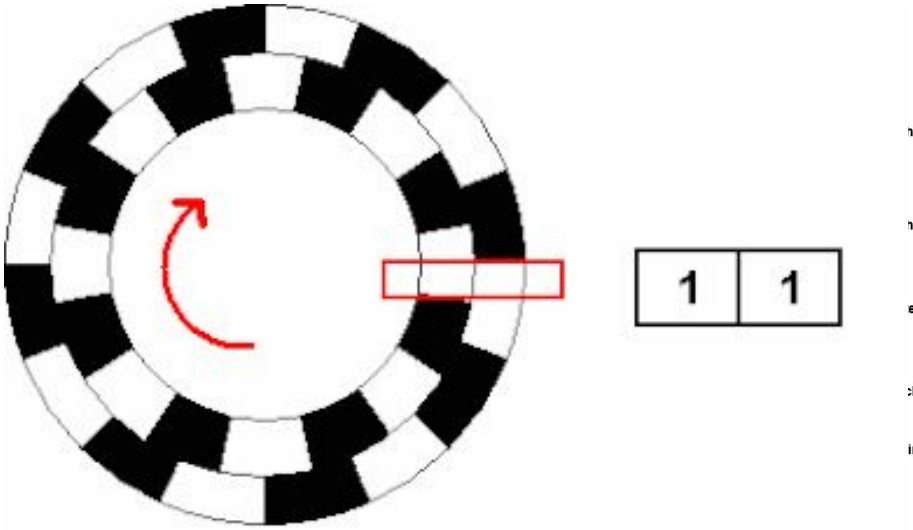
- No contact between moving and stationary parts and thus low friction
- Often requires closed-loop control
- Expensive as H*ck

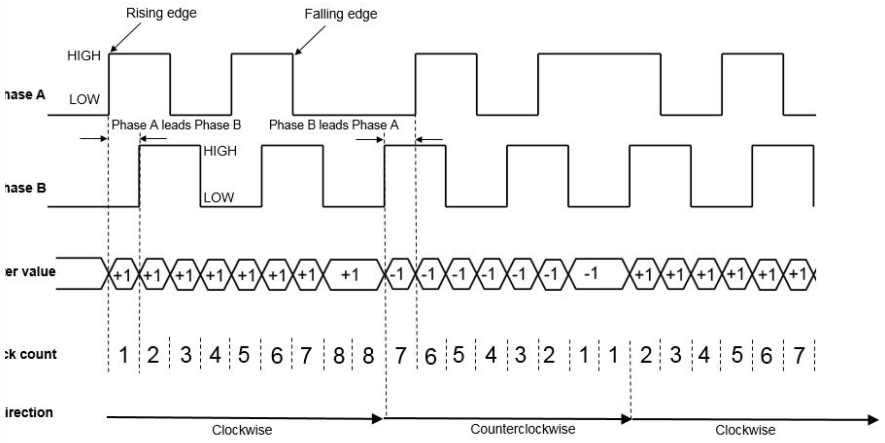
Encoders

- Measures speed (or position) of motor
- Absolute and Incremental
- Direction measurement happens through phase shift (quadrature)



Incremental Encoder





Lab

Task - Controlling 5V Motor

- Send command through Arduino Serial monitor to set motor to move in a given direction
  - Only requires Arduino and H-Bridge
- Send speed and direction commands
  - Use PWM to control desired transistors

https://github.com/RoboJackets/electrical-training/tree/master/week_2_material