Mens et Manus

Brushless Motors

October 20, 2020

Electronic Circuits in Technology-Enabled Devices

Electronics inside an electric fan motor.

Electronics inside a Tesla Model 3 Motor.

Using a Microprocessor in a Simple Electronic Device

Our first few projects focused on the use of a microprocessor to control light from an LED.

Using a Microprocessor to Control Magnets

We used the same microprocessor to control force and motion.
Control of Electromagnetism in Electric Motors

Electronics inside an electric fan motor.

Electronics inside a Tesla Model 3 Motor.

Motor Operation: Basic Principles

Switch currents to electromagnets to rotate applied magnetic field.

Today's Project: Build a Motor

Four electromagnets in stator and six permanent magnets in rotor.

Assemble the Motor Hardware

See the lab handout for detailed assembly instructions.

Removing Protective Paper From Laser-Cut Acrylic

Assembling the Rotor

Rotor magnets: alternate north and south poles facing perimeter.
**Today's Project: Build a Motor**

Determine the sequence of voltages needed for clockwise rotation.

North faces **outward** for rotor magnet near coil A1 but **inward** for coil A2.

Radial anti-symmetry → drive coils A1 and A2 with opposite voltages.
→ drive coils B1 and B2 with opposite voltages.

Set B coils with North facing left → clockwise torque.

Set A coils with North facing down → rotor will rotate clockwise.

Set B coils with North facing left → rotor will rotate clockwise.

Set A coils with North facing down → rotor will rotate clockwise.
Choreography
Determine the sequence of voltages needed for clockwise rotation.

Set B coils with North facing left → rotor will rotate clockwise.
Set A coils with North facing down → rotor will rotate clockwise.
Set B coils with North facing right → clockwise torque.

Set B coils with North facing left → rotor will rotate clockwise.
Set A coils with North facing down → rotor will rotate clockwise.
Set B coils with North facing right → clockwise torque.

Set A coils with North facing up → clockwise torque.

Electrical Connections
Connect opposing coils to same H-bridge, flip white and black leads.

coil A+: coilA1 white and coilA2 black
coil A–: coilA1 black and coilA2 white
coil B+: coilB1 white and coilB2 black
coil B–: coilB1 black and coilB2 white
**Test Motor**

Use code provided in lab handout.

// brushless motor: stepper mode
#define AIN1 0 // H-bridge A, input pin 1
#define AIN2 1 // H-bridge A, input pin 2
#define BIN1 2 // H-bridge B, input pin 1
#define BIN2 3 // H-bridge B, input pin 2

void setup(){
  pinMode(AIN1,OUTPUT); // set H-bridge control pins as Teensy outputs
  pinMode(AIN2,OUTPUT);
  pinMode(BIN1,OUTPUT);
  pinMode(BIN2,OUTPUT);
}

void hbridge(int in1,int v1,int in2,int v2){
  digitalWrite(in1,v1);
  digitalWrite(in2,v2);
  delay(20);
}

void loop(){
  hbridge(AIN1,LOW,AIN2,HIGH);
  hbridge(BIN1,HIGH,BIN2,LOW);
  hbridge(AIN1,HIGH,AIN2,LOW);
  hbridge(BIN1,LOW,BIN2,HIGH);
}

**Breakout Groups**

We will divide up now to work in small groups on this week’s project.