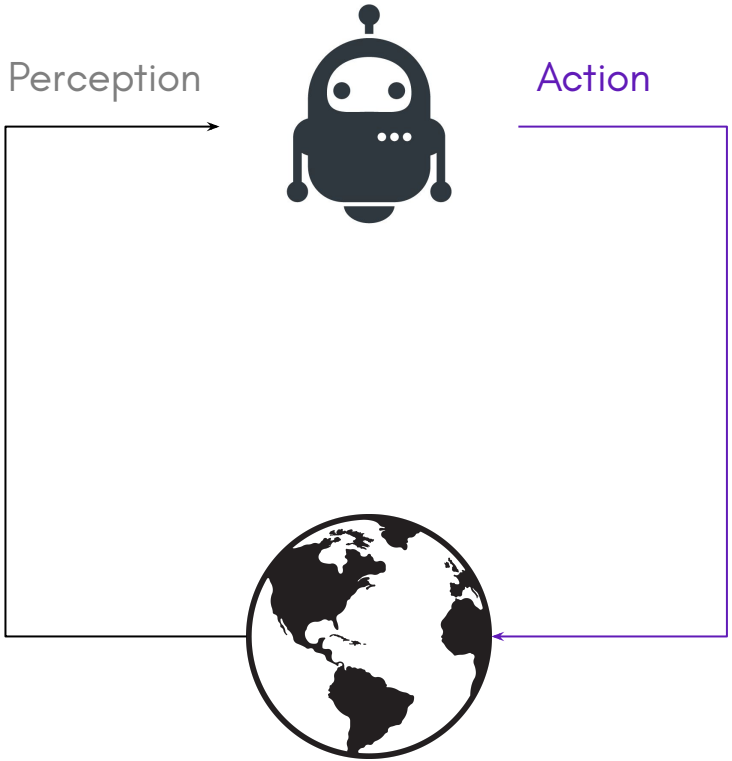
ENGR 3421: Robotics I

Motors Spin-Up

09/17/2024

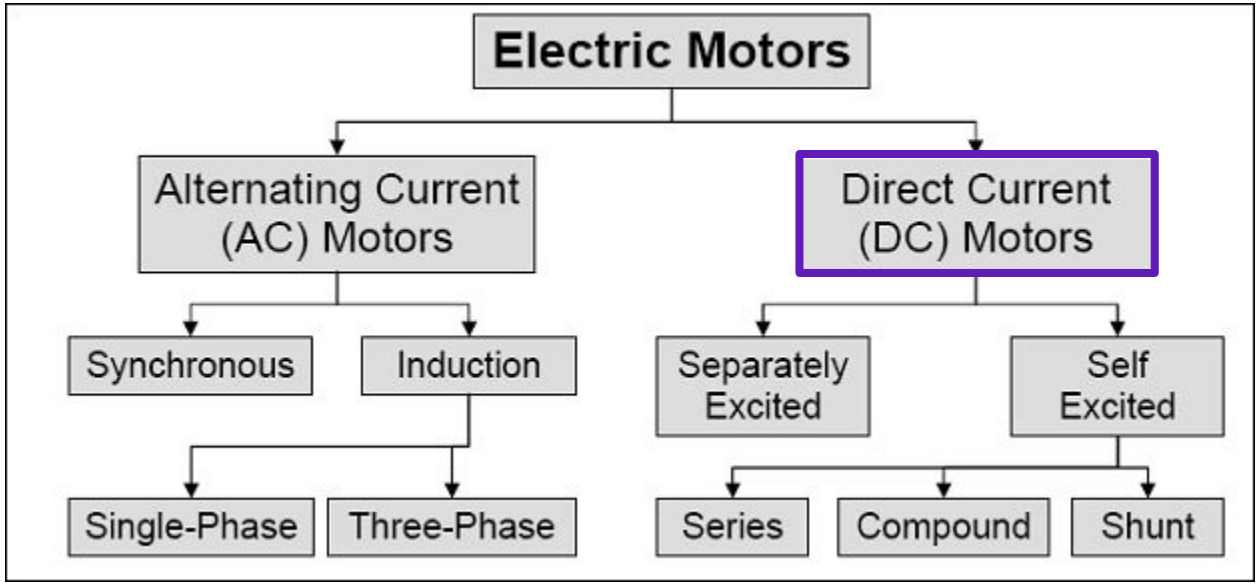
A Robot Needs to Move



Actuators

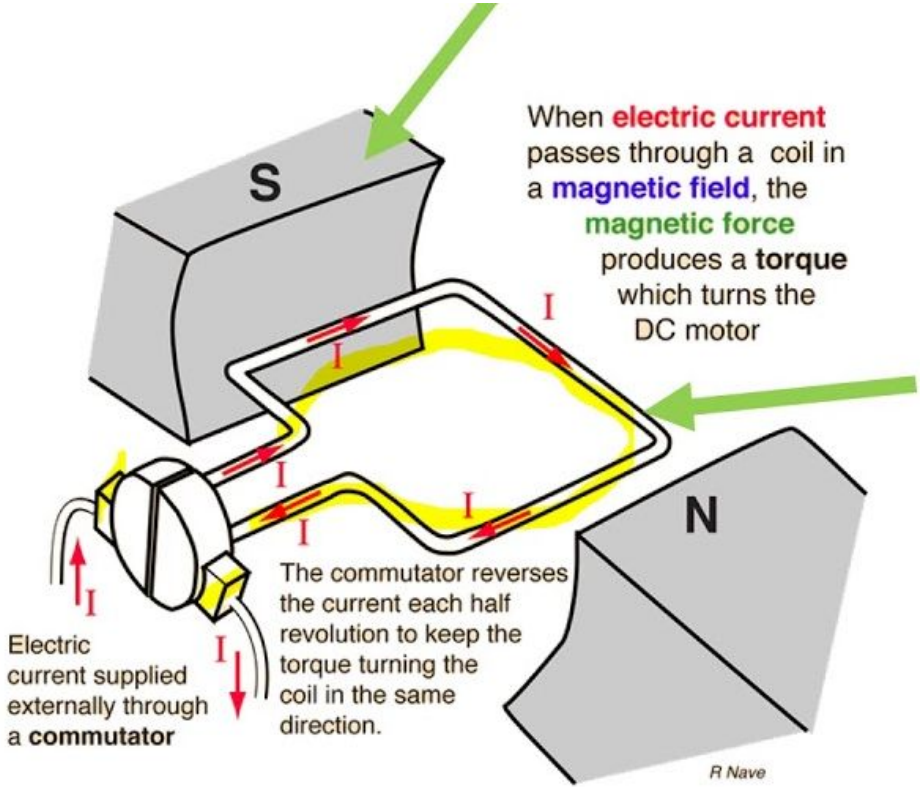
- Motors
- Hydraulic Actuators
- Pneumatic Actuators
- Solenoids
- Artificial Muscles
- ...

Types of Motors



DC Motors

How does a DC Motor Work

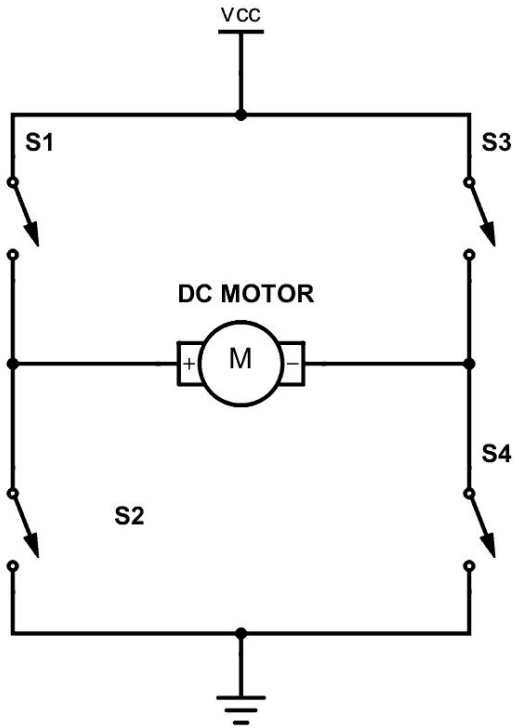


Gearmotor

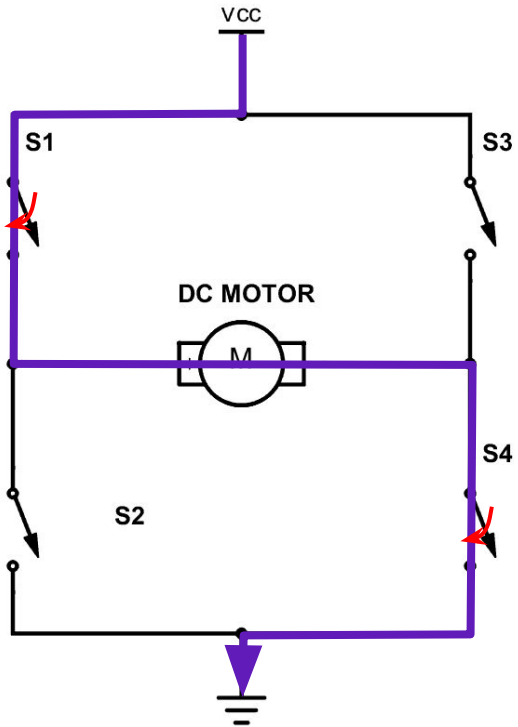
voltage	no-load performance	stall extrapolation
6 V	210 RPM, 500 mA	9.1 kg·cm (130 oz·in), 6.0 A

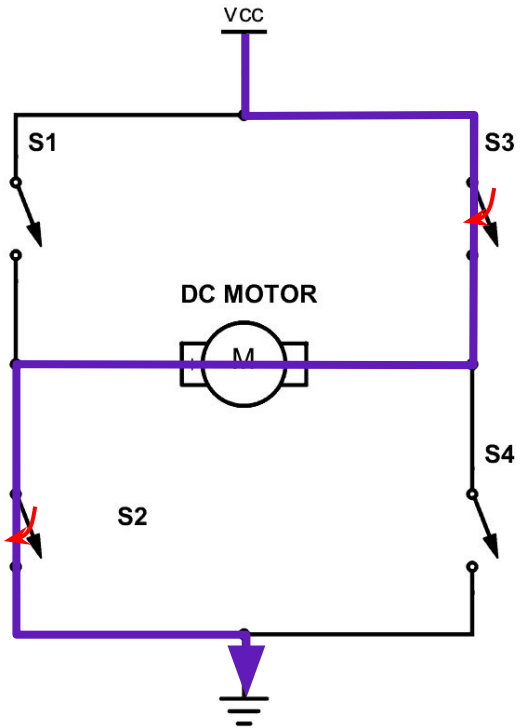
Gear ratio:	**46.85:1**
No-load speed @ 6V:	210 rpm
No-load current @ 6V:	0.50 A
Stall current @ 6V:	**6.0 A**
Stall torque @ 6V:	9.1 kg·cm
Max output power @ 6V:	4.9 W
Motor type:	6V, 6.0A stall (HP 6V)

H-bridge Driving Circuit

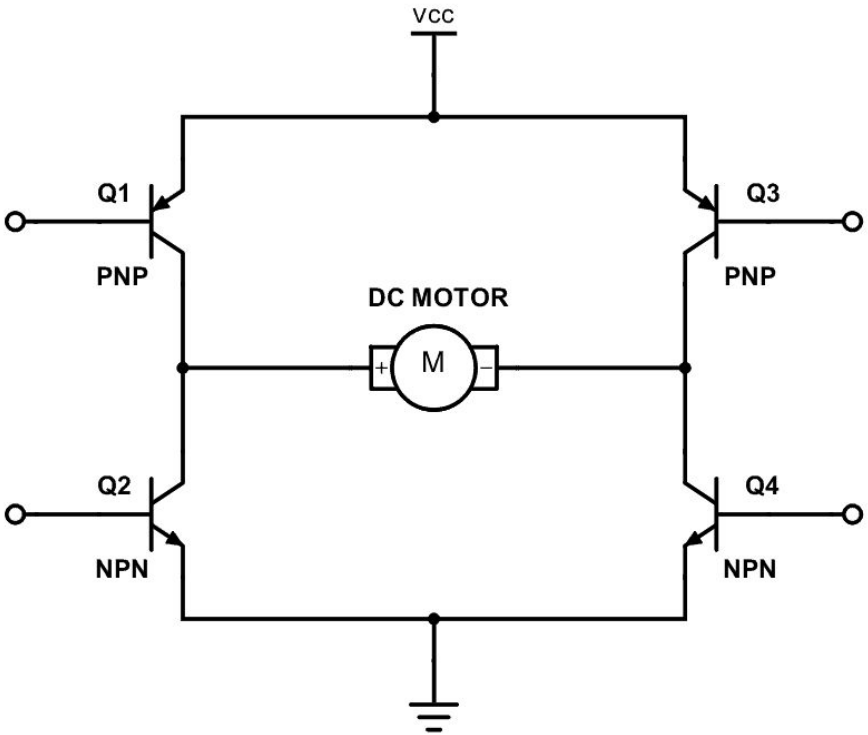


H-bridge Driving Circuit





Transistor H-bridge



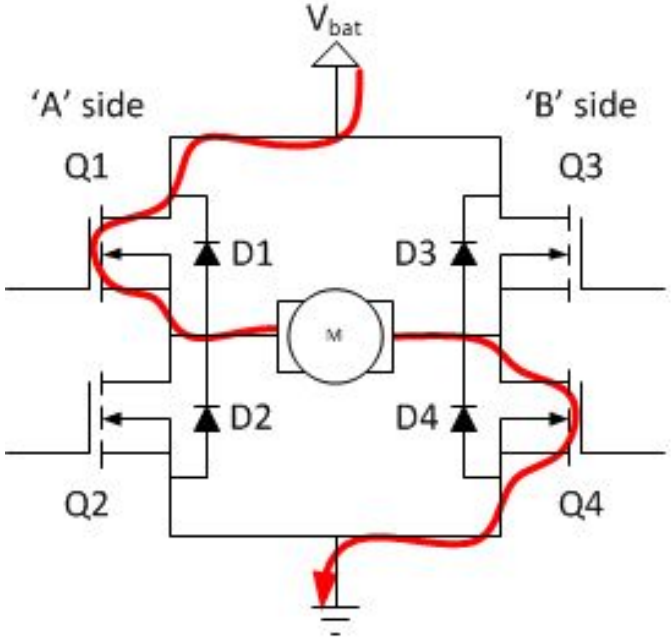
Transistors drop = 0.7 V

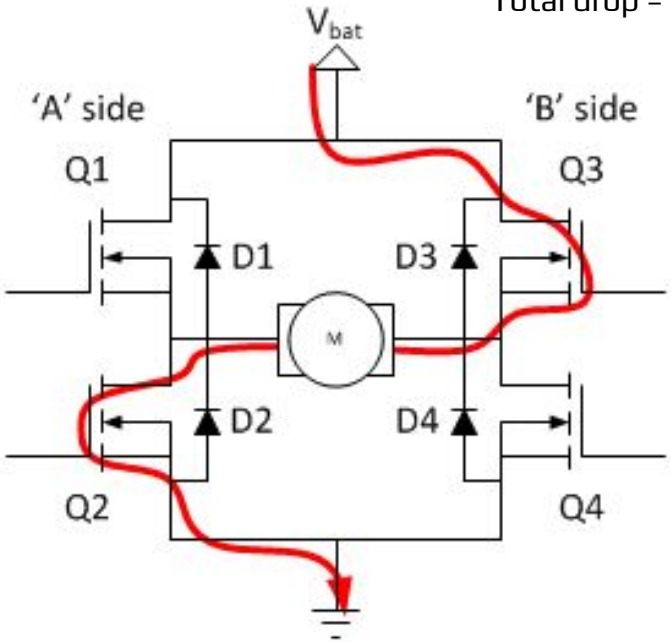
Total drop = 1.4 V

MOSFET H-bridge

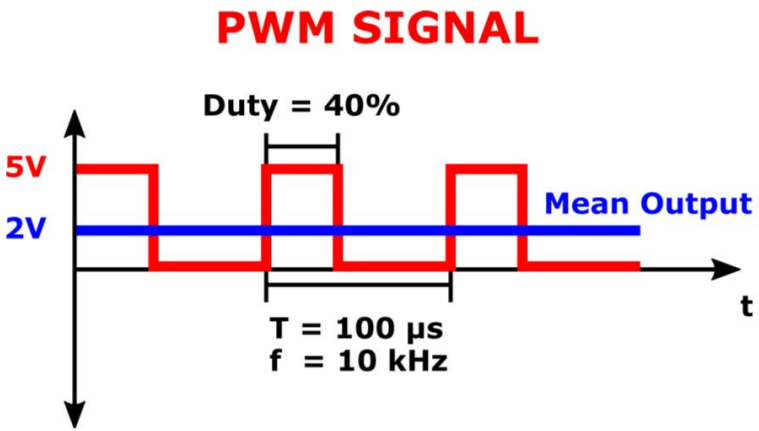
MOSFET drop = 0.1 V

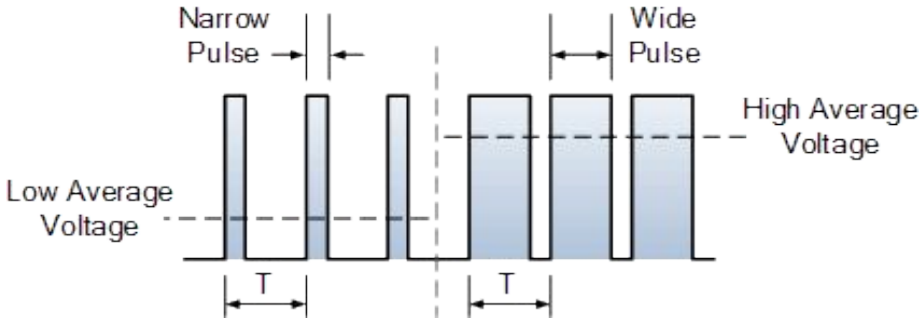
Total drop = 0.2 V



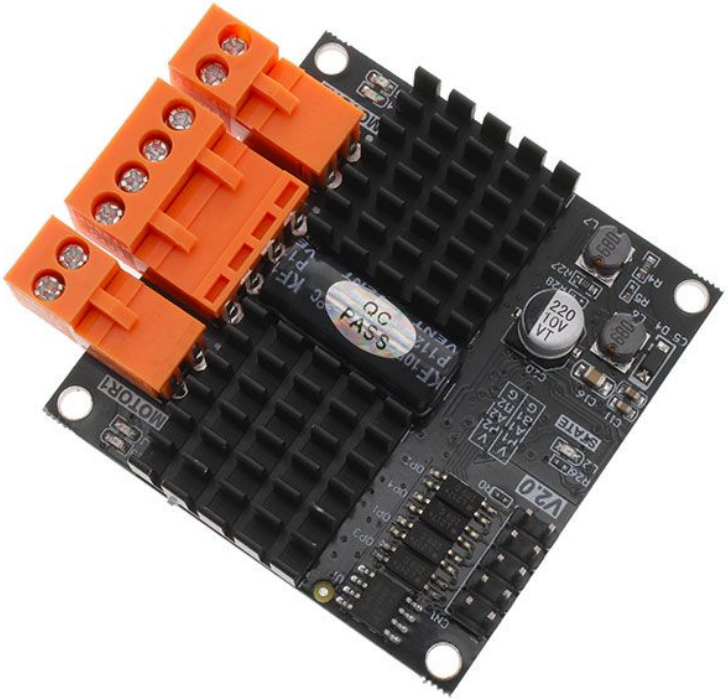


Pulse Width Modulation (PWM)

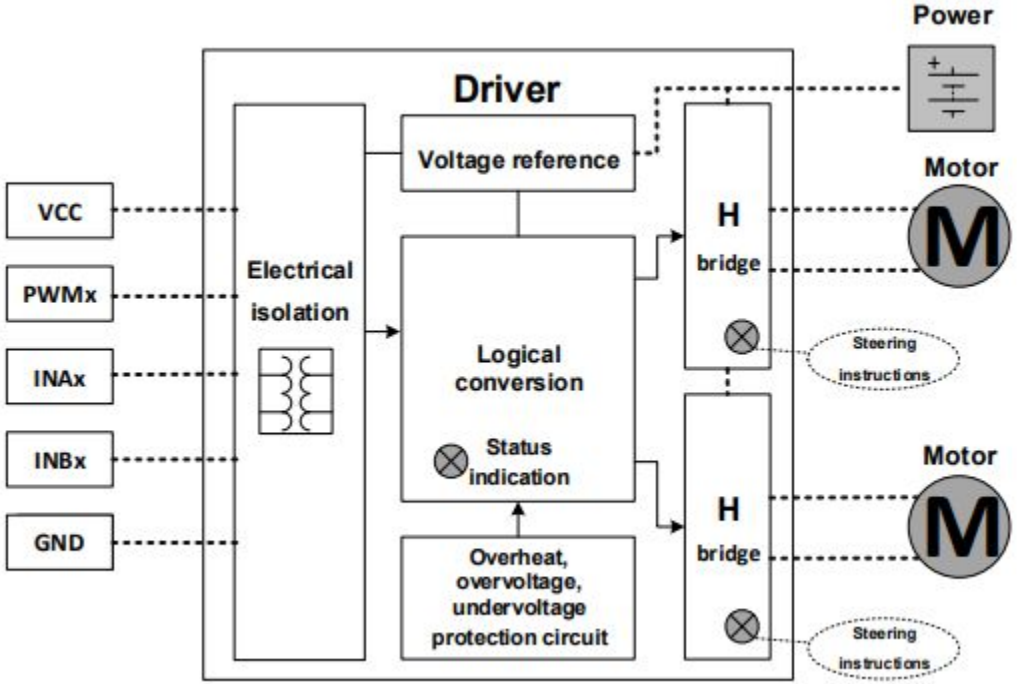




Motor Driver Board - DFR0601



Motor Driver Wiring



Drive DC Motors

```
from machine import Pin, PWM
from time import sleep

# Config pins
INA_LEFT = Pin(11, Pin.OUT)
INB_LEFT = Pin(12, Pin.OUT)
INA_LEFT.off()  # INA_LEFT.value(0)
INB_LEFT.off()
PWM_LEFT = PWM(Pin(13))
PWM_LEFT.freq(1000)
```

```
# Spin motor
INB_LEFT.on()  # forward
PWM_LEFT.duty_u16(int(65025 / 3))  #
1/3 max speed
sleep(4)  # spin 4 sec
# Stop
PWM_LEFT.duty_u16(0)
INA_LEFT.off()
INB_LEFT.off()
sleep(1)
INA_LEFT.on()  # backward
PWM_LEFT.duty_u16(int(65025 / 3))
sleep(4)
PWM_LEFT.duty_u16(0)
INA_LEFT.off()
INB_LEFT.off()
```

Can you ramp up and down motor speed?

Can you drive both motors?

Motor Driver Class (Template)

```
from machine import Pin, PWM
class MotorDriver:
    def __init__(self, ina_id, inb_id, pwm_id):
        self.ina_pin = Pin(ina_id, Pin.OUT)
        self.inb_pin = Pin(inb_id, Pin.OUT)
        self.pwm_pin = PWM(Pin(pwm_id))
        self.pwm_pin.freq(1000)
        # Stop motor
        self.pwm_pin.duty_u16(0)
        self.ina_pin.off()
        self.inb_pin.off()
    def stop(self):
        self.pwm_pin.duty_u16(0)
    def forward(self, duty):
        self.ina_pin.on()
        self.inb_pin.off()
        self.pwm_pin.duty_u16(duty)
    def backward(self, duty):
        self.ina_pin.off()
        self.inb_pin.on()
        self.pwm_pin.duty_u16(duty)
```

```
# Test
if __name__ == '__main__':
    from time import sleep
    md = MotorDriver(18, 19, 20)
    md.forward(40000)
    sleep(4)
    md.stop()
```

Double Motor Driver Class (Template)

```
from motor_driver import MotorDriver
class DualMotorDriver:
    def __init__(self, lmotor_ids, rmotor_ids):
        self.left_motor = MotorDriver(*lmotor_ids)
        self.right_motor = MotorDriver(*rmotor_ids)
    def forward(self, duty):
        self.left_motor.forward(duty)
        self.right_motor.forward(duty)
    def backward(self, duty):
        self.left_motor.backward(duty)
        self.right_motor.backward(duty)
    def spin_left(self, duty):
        self.left_motor.backward(duty)
        self.right_motor.forward(duty)
    def spin_right(self, duty):
        self.left_motor.forward(duty)
        self.right_motor.backward(duty)
    def stop(self):
        self.left_motor.stop()
        self.right_motor.stop()
```

```
# Test
if __name__ == '__main__':
    from time import sleep
    dmd = DualMotorDriver((11, 12,
13), (18, 19, 20))
    dmd.forward(40000)
    sleep(2)
    dmd.stop()
    sleep(0.25)
    dmd.backward(40000)
    sleep(2)
    dmd.stop()
    sleep(0.25)
    dmd.spin_left(40000)
    sleep(2)
    dmd.stop()
    sleep(0.25)
    dmd.spin_right(40000)
    sleep(2)
    dmd.stop()
    sleep(0.25)
```

Dual Motor Driver Usage

```
from dual_motor_driver import DualMotorDriver
from time import sleep

# SETUP
bot = DualMotorDriver((11, 12, 13), (18, 19, 20))

# LOOP
for i in [0, 10000, 25000, 50000]:
    bot.forward(i)
    sleep(1)
for i in reversed([0, 10000, 25000, 50000]):
    bot.forward(i)
    sleep(1)
bot.stop()
```