Project 4: Motor Control
Four ducted fans for our hovercrafts:

- **Three lateral fans:**
  - Brushed motors
  - Bidirectional control
  - H-Bridges

- **One lift fan:**
  - Brushless motor
  - Unidirectional control
  - Electronic Speed Control (ESC) unit
Component 1: Circuit

- **Right side:**
  - H-bridge to battery power
  - H-bridge to fans

- **Left side:** H-bridge to Teensy
  - Teensy power (+5V) and ground
  - For each fan: PWM magnitude and 2 direction control signals
    - Lift fan: hard-wire direction to push air into the lower chamber

Be careful with direct battery power!
Component 2: Supporting Types/Implementation

**Top of program:**
// Promise that we will implement this function later
void fsm_step();

// Create a task that will be executed once per 50 ms
PeriodicAction fsm_task(50, fsm_step);

// Gains to be used for reverse thrust
const float FAN_GAIN[] = {1.0, 1.0, 1.0};

**Loop:**
void loop()
{
    // Check to see if it is time to execute the fsm_task
    fsm_task.step();
}
Component 3: Interface Functions

```c
int16_t clip(float value, float min_value, float max_value)

void set_lateral_fan_magnitudes(float magnitude[3])
  • Each magnitude in the range -127 ... 127
  • For reverse thrust: magnitude is multiplied by corresponding FAN_GAIN before setting the PWM duty cycle
```
Setting PWM Duty Cycle

analogWrite(pin, duty);
• pin = Arduino pin
• duty in [0 … 255] (0% to 100%)

• Note: negative duty cycles do not make sense
Component 4: Finite State Machine

fsm_step() will implement the following behavior:

When switch is pressed:

• Lateral fans:
  • Ramp left up to 25% duty cycle, then down to -25%, then 0%,
  • Right: same sequence
  • Back: same sequence
Coding

• `fsm_step()`:
  • Called once every 50ms
  • Do not include for, while or sleep. Instead, rely on the fact that the function will be called regularly

• Make sure that each function that you implement does exactly what the specification says & no more

• Stick to the documentation specification
New Hardware to Install

• Dual H-Bridge modules
• Be careful with the battery power! (go slow)

• New central fans will be installed over the next 2 weeks (see Zach to schedule this)