Project 3

Project 3 Objectives

At the end of this project, you should be able to:

- control the speed and direction of DC motors through an H-bridge circuit,
- implement and tune a proportional-derivative control law that maintains the hovercraft's heading at some desired orientation, and
- implement a high-level control law that decides when to brake and when to use the PD control law.

Part 1: Circuit

- Mount motor amplifier board
- Connect ducted fans to the output side
- Connect microprocessor to the input side
- Keep away from the compass

Part 2: Fan Control Interface

Must implement:

- `void set_middle_direction(MotorDirection direction)`
  - Determines whether the middle fan is pushing air into or out of the chamber

- In project.h, define:

```
typedef enum {
   BRAKE,
   HOVER
} MotorDirection;
```

  - This new data type has two values: BRAKE and HOVER

Part 2: Fan Control Interface

Must implement:

- `void set_middle_magnitude(int16_t magnitude)`
  - Sets the duty cycle of the middle fan. Must ensure that `magnitude` is in the range [0 … 1023]

- `void set_lateral_magnitudes(int16_t magnitude_left, int16_t magnitude_right)`
  - Sets the duty cycle of the left and right fans. Must ensure that the magnitudes are in the valid range

- Initialization of the PWM channels (more on this today)

Part 3: Proportional-Derivative Control

Must implement:

- `void pd_control(int16_t error, int16_t rotation_rate, uint16_t forward_thrust)`
  - Implements the PD-control law: compute a left/right differential
  - Add this differential to forward_thrust to derive duty cycle signals for the left/right fans
  - Use the computed duty cycles to set the fan speed

Note: test slowly

Part 4: Main Program

- Start with the template in the project specification and fill in your own code as necessary

- The interrupt service routine sets the flag_timing variable to 1 every 49.152 ms
  - This allows us to ensure that we have ~20 control cycles per second.

Part 5: Hovercraft

- Mount the motor amplifier board
- Connect the board to the batteries (motor power pins only - not the logic pins!)
- No wires near the fans

Checkpoint

- 30 minute meeting within one week
- Have much of parts 1-3 completed and tested
- A successful checkpoint is worth 10% of the project grade