DC Motors

• Current (ideally) is proportional to the torque produced by the motor
• Direction of current flow determines torque direction

How can a digital input control torque magnitude?
DC Motors

How can a digital input control torque magnitude?

- Use PWM!

How do we handle torque direction?
DC Motors

How do we handle torque direction?
• +5V to north 0V to south
• 0V to north +5V to south

How would we implement this?
DC Motor Control

One possibility…

- Connect motor directly to the I/O pins

Two directions:
- PD2: 1; PD3: 0
- PD2: 0; PD3: 1
DC Motor Control

One possibility…
- Connect motor directly to the I/O pins

What is wrong with this implementation?
DC Motor Control

What is wrong with this implementation?

• Our I/O pins can source/sink at most 20 mA of current
• This is not very much when it comes to motors…

How do we fix this?
Simple H-Bridge
Simple H-Bridge

What happens with these inputs?
Simple H-Bridge

What happens with these inputs?

- Motor turns in one direction

+5V

1

0

0

1
Simple H-Bridge

How about these inputs?
Simple H-Bridge

What happens with these inputs?

- Motor turns in the other direction!
Simple H-Bridge

How about these inputs?
Simple H-Bridge

What happens with these inputs?

• We short power to ground
• ... very bad
Simple H-Bridge

How can we prevent a processor from accidentally producing this case?
Modified H-Bridge

We introduce a little logic to ensure the short never occurs.
What happens with this input?
Modified H-Bridge

What happens with this input?
Modified H-Bridge

What happens with this input?

- Motor turns in one direction
Modified H-Bridge

How about this input?
Modified H-Bridge

What happens with this input?
Modified H-Bridge

How about this input?

- Motor turns in the other direction
Modified H-Bridge

This implementation is nice because we only need one direction bit of control

• What are we missing?
Modified H-Bridge

What are we missing?
• Control of torque magnitude
• Let’s introduce a second PWM input

What would this look like?
PWM and Direction Control
PWM and Direction Control

What happens with this input?
PWM and Direction Control

What happens?

• No current flow
PWM and Direction Control

What happens now?
PWM and Direction Control

What happens now?

• ‘x’ determines motor direction
PWM and Direction Control

**Direction**

With the PWM input, we can control the magnitude of torque.