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?

www.tpub.com

www.pcgadgets.com
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?

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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

+5V
Simple H-Bridge

What happens with these inputs?
Simple H-Bridge

What happens with these inputs?

- Motor turns in one direction
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?
We introduce a little logic to ensure the short never occurs
Modified H-Bridge

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.