IMGD 3xxx - HCI for Real, Virtual, and Teleoperated Environments: Physical Feedback

by

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Motivation

- We've looked at how to get (some) physical input from the user
- Now we look at providing physical feedback
- Sound and vision are important
  - Often, though, they are all that are used by designers
- There is something special about receiving physical feedback
  - Different part of the brain
  - Different properties can be conveyed
  - E.g., the sound of wind vs. wind

Design Space of Physical Feedback

- We need to think about designing *machines*
  - Kind of cool!
- We need to glue mechanical and electrical engineering together with programming
  - Understanding things is tougher
    - Need EE background, and possibly some ME
  - Debugging is tougher
    - Need to analyze current, etc.
- Does this sound familiar?
  - This is what RBE is all about!
- Reward:
  - Design and build stuff that acts in the real world!

Design Tips

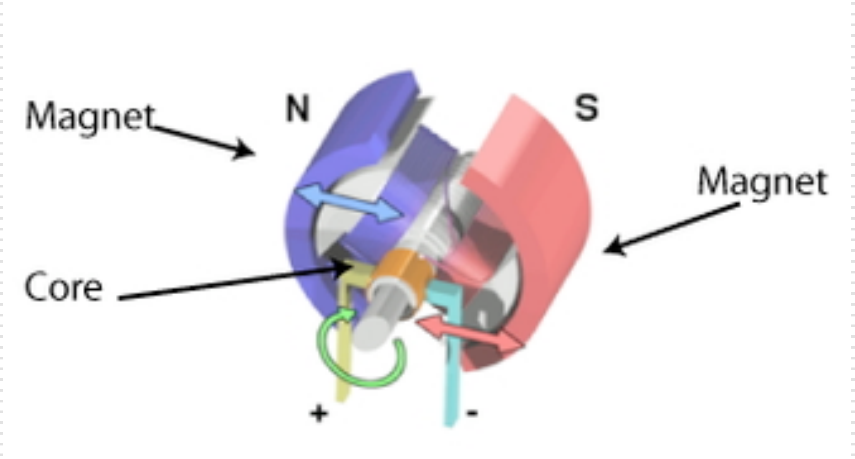
- Map analog (continuous) values to analog displays
- Map binary (discrete) values to binary displays
- Pay attention to user attention
- Measure and refine to improve user performance/experience
- Keep physical, visual, and audio feedback synchronized
- Be aware of the use environment
  - Car blinker

Primary Tool: Motors

- Many interesting feedback systems can be created using motors
  - DC motors
  - Servos motors
  - Stepper motors

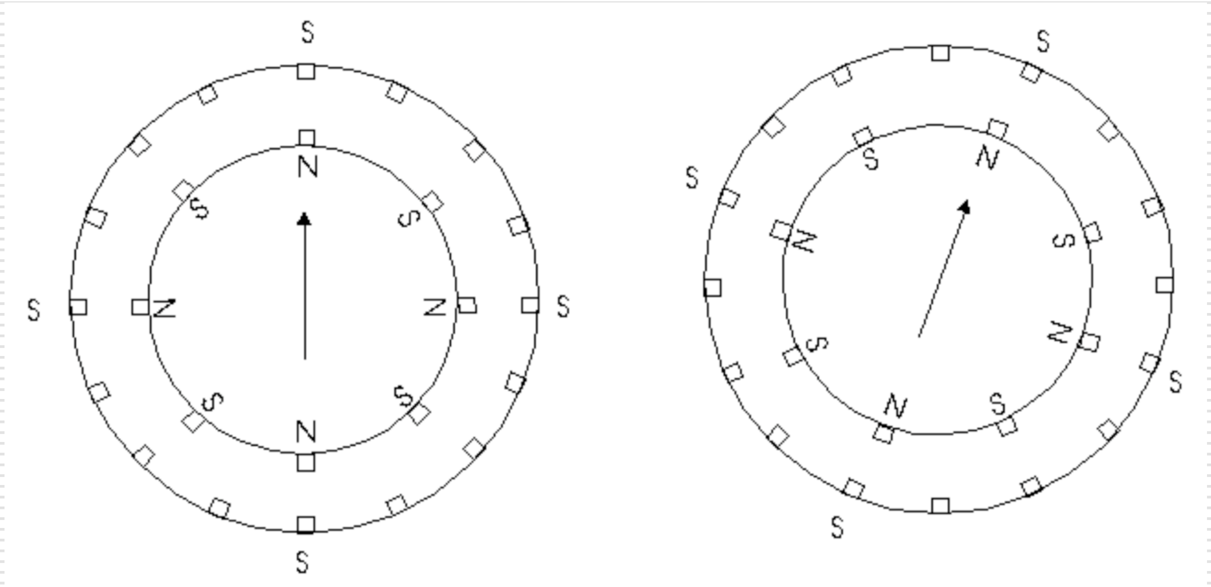
DC Motors

- Motor spins using magnetism
  - Electromagnetic coil + fixed magnets
- Switch the polarity every half-turn
- Can reverse direction using an H-Bridge



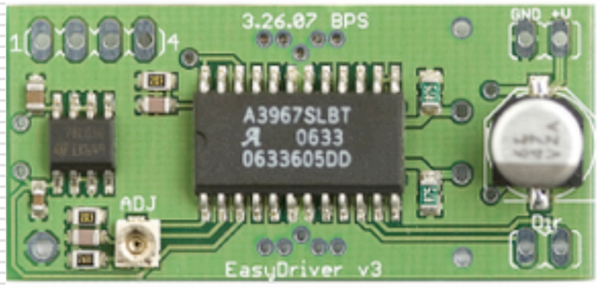
Stepper Motors

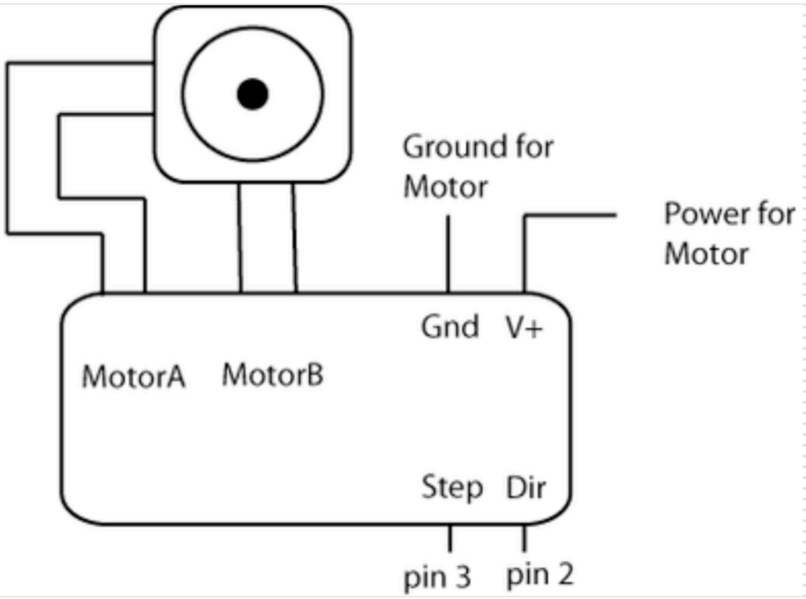
- Motor (again) spins using magnetism
- Multiple electromagnets in a circle allow the motor to "step" to a desired position



Stepper Motors (cont.)

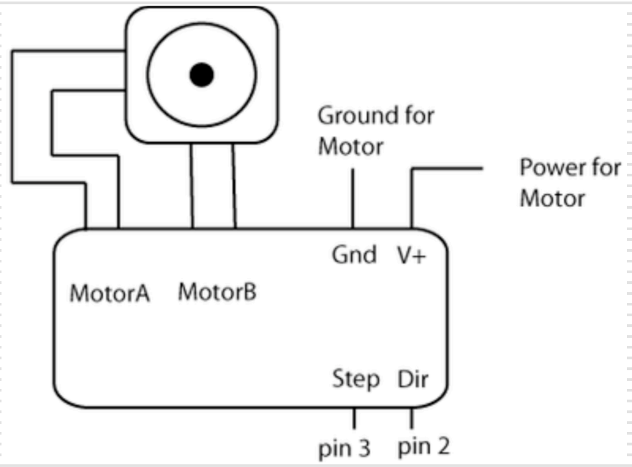
- Stepper driver board makes things easier
- Connect to Arduino pins





Stepper-Motor Code

```
int dirPin = 2;
int stepperPin = 3;
void setup( ) {
  pinMode( dirPin, OUTPUT );
  pinMode( stepperPin, OUTPUT );
}
void step( boolean dir,int steps )  {
  digitalWrite( dirPin, dir );
  delay( 50 );
  for( int i = 0; i < steps; i++ )  {
    digitalWrite( stepperPin, HIGH );
    delayMicroseconds( 100 );
    digitalWrite( stepperPin, LOW );
    delayMicroseconds( 100 );
  }
}
```



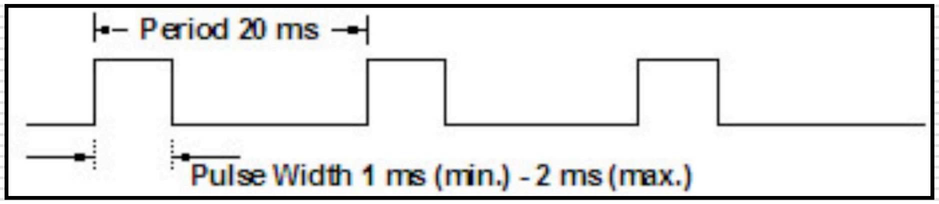
```
void loop( )  {
  step( true, 1600 );
  delay( 500 );
  step( false, 1600*5 );
  delay( 500 );
}
```

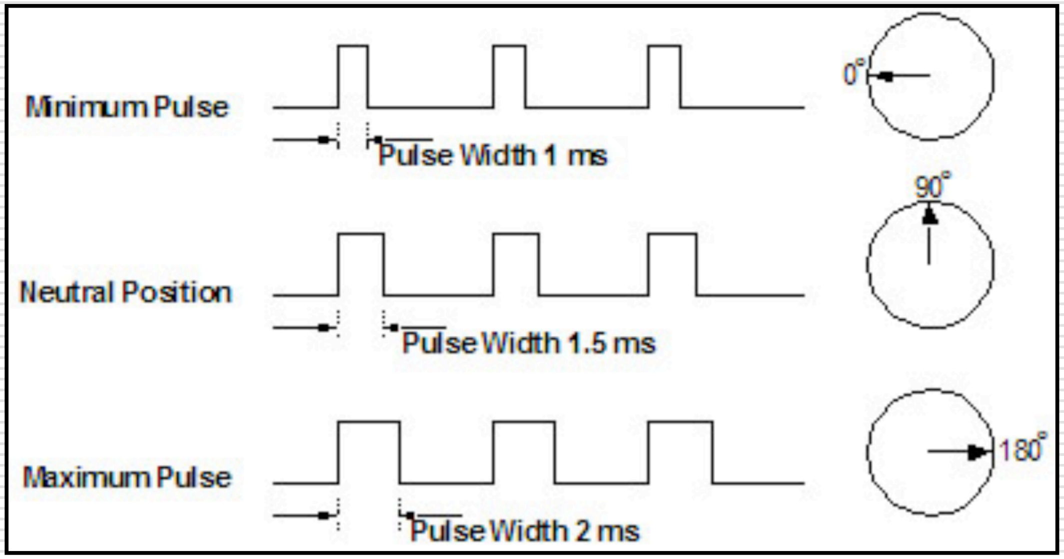
Servo Motors

- A servo is a motor with some "extra" features
  - It reads the voltage passed to it, and decides how far to rotate within a given range (e.g., 180˚)
- Cool fact:
  - The same code used to control small servos can be used to control honkin' servos
  - Think big!
- Not-so-cool fact:
  - You can't control servos using the "normal" PWM outputs on the Arduino
  - You have to "roll-your-own" PWM

Servo Motors (cont.)

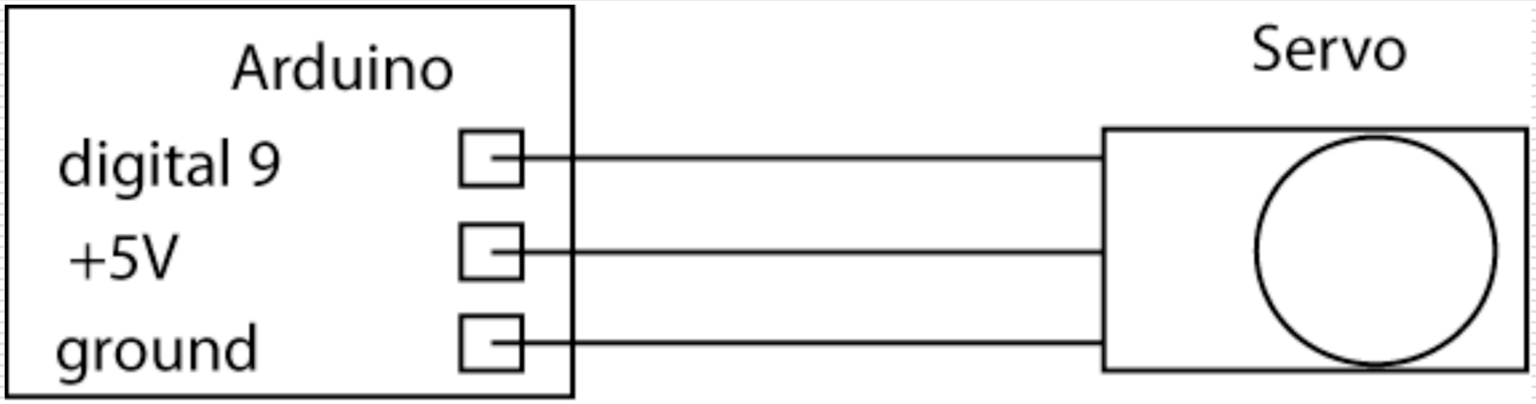
- Actually, it's not that bad





Servo Motors (cont.)

- Three wires
  - Red (usually) is power
  - Black (usually) is ground
  - Yellow (or white) goes to a digital pin



Servo-Motor Code

```
#include <Servo.h>

Servo myservo;  // create the servo object
int potpin = 0;  // analog pin used to connect the potentiometer
int val;    // variable to read the value from the analog pin

void setup( )  {
  myservo.attach( 9 ); // attaches the servo on pin 9 to the servo object
}

void loop( )  {
  // Read the value of the potentiometer
  // (value between 0 and 1023)
  val = analogRead( potpin );

  // Scale it to use it with the servo
  // (value between 0 and 180)
  val = map( val, 0, 1023, 0, 180 );

  // Sets the servo position according to the scaled value
  myservo.write( val );

  // Wait for the servo to get there
  delay( 15 );
}
```

Steppers and Servos

- Servos are similar to Steppers
- Servos are smoother than Steppers
  - Better for continuous motion
- Steppers are better for "locking" in place or moving to a predefined position
- Can get multipurpose Arduino shields (AdaFruit)
  - 2 Servos
  - 4 DC motors
  - 2 Steppers
  - Screw-down terminals