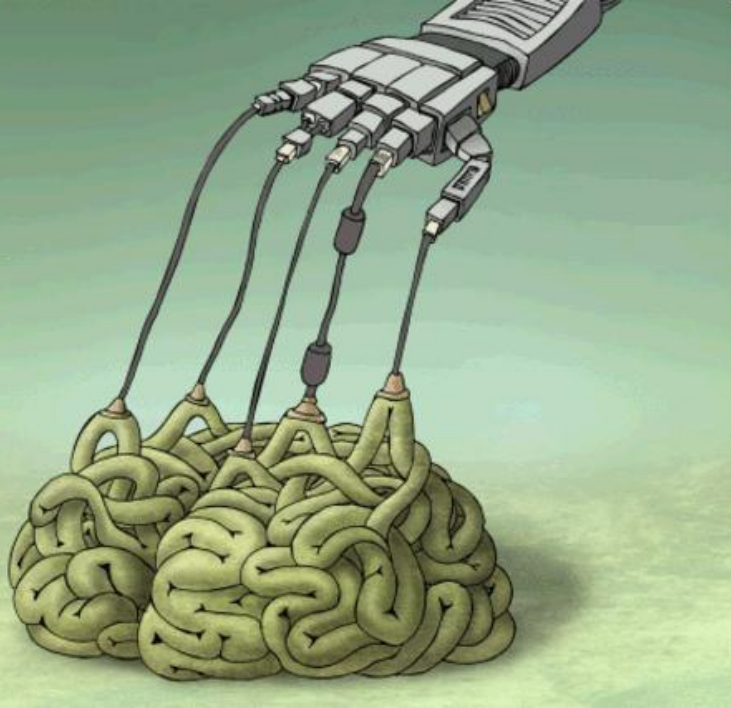# THINK TANK

Colin Robinson
Josh Merchant
Woojin Koh

So why research and fabricate a human-computer interface?

- There is a growing interest in the field

- More and more companies are pursuing research and products in the area

- It allows for the ability to better understand how our brains function and process thoughts

Emotiv EPOC

- The Emotiv EPOC is a wireless human-computer interface that allows a user to manipulate electrical signals from the brain

- 14 sensors that process and transmit EEG data to a PC

- Gyroscope

- 12 hour rechargeable battery

- Signal amplification and filtering already done inside the headset

Basically…

Electricity flows around the body basically as ions in solution and the least invasive and lowest-noise method of picking up these signals is to continue the process to a dedicated electrochemical electrode.

In the case of the EPOC headset saline solution is applied to felt pads on top of the electrodes the headset holds. The saline acts as a conducting solution to carry the signal from the body to the headset.

Some facts about the Emotiv EPOC headset

• Compared to a medical grade device, voltage and time resolution are lower and noise floor higher but overall spectra and signals are well-matched

• Data within the headset is recorded at 2048 samples/sec per channel (using a 16-bit ADC) in order to allow precise phase locking between signals on all channels

• The data is filtered and downsampled to 128/sec/ch but actual phase differences into the filters are minimal - less than 0.5ms - unlike a raw 128/sec system which can have about 7ms of effective phase difference between channels.

• There is a hardware low-pass filter in each channel preamp with an 85Hz cutoff, and a hardware high-pass on each input with 0.16Hz cutoff.
The digital notch filters at 50Hz and 60Hz put a big dent in the bandpass, so the creators specify a fairly flat response from 0.16 - 43Hz with a roll-off to -85dB at 50Hz, a bounce back to -5dB at 55Hz, another 80dB hole at 60Hz and the filter is still fairly low at the 64Hz Nyquist frequency from the 128Hz channel transmission rate.

Emokey

- Provided with Emotiv EPOC
- Allows the user to map thoughts and facial expressions
- We then take the mapped thoughts and facial expressions and program them to perform certain commands
- Provides a graphical interface to help with training the program to recognize specific thoughts
- It runs in the background of other programs allowing for full attention on the task at hand
- Made for research and video game development
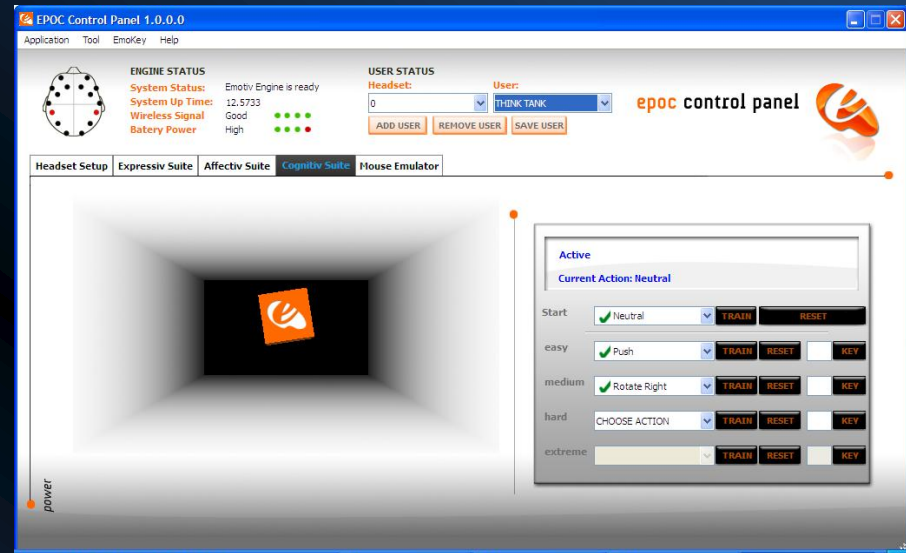
EEG

2.4GHz Wireless

USB

Custom Software to send Commands to phone

Emotiv Software

SSH Client

Laptop

3.5mm audio cable

SSH Server

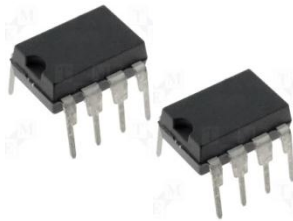Custom App to send Acoustic data

Phone
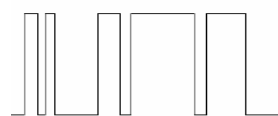
Arduino

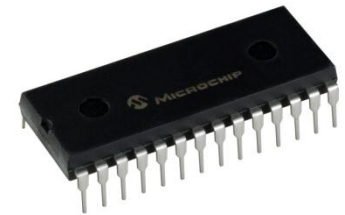Software to match received signal against known signals

Arduino

Stepper Motors   Dual H-Bridges   Shift Register
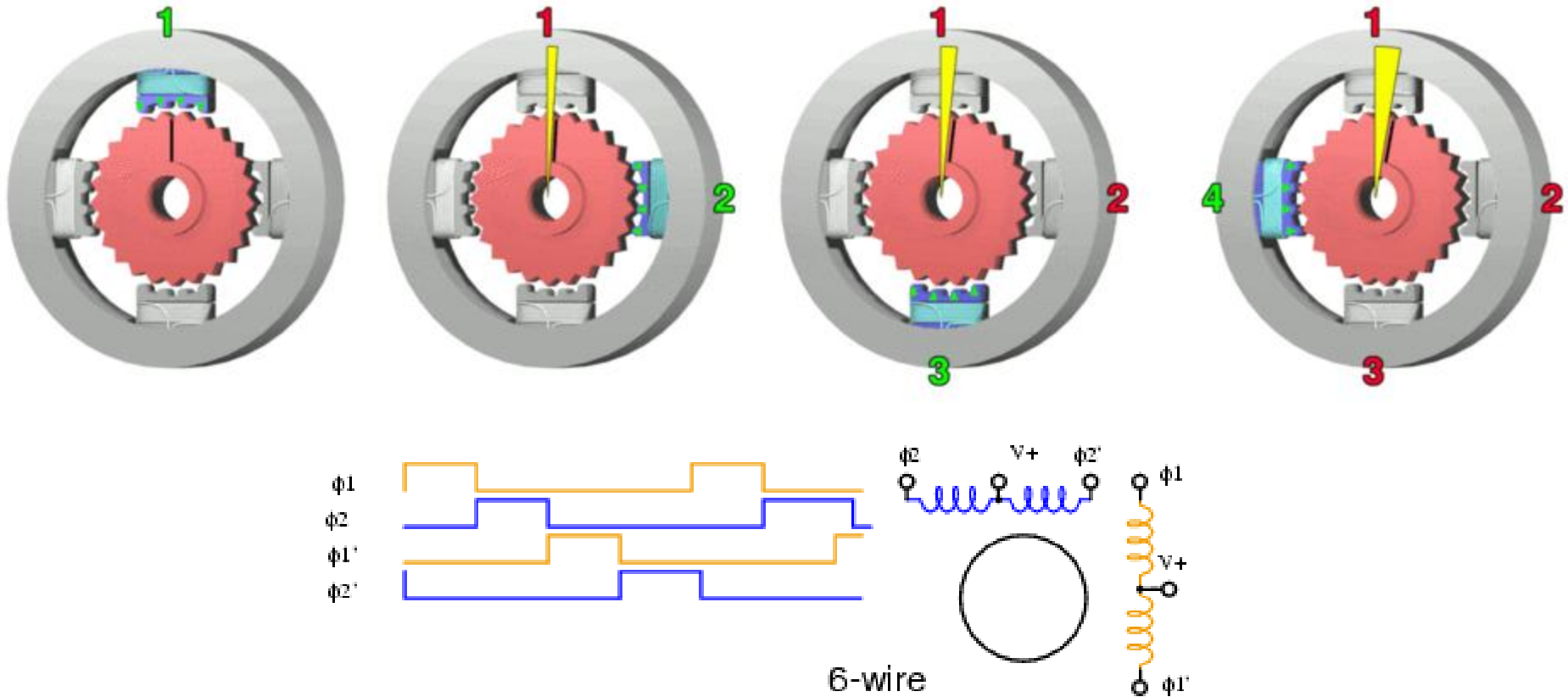
Motor Controller

Movement: Stepper Motor

- Two types of Motors
  - Unipolar
  - Bipolar
- Unipolar Motor
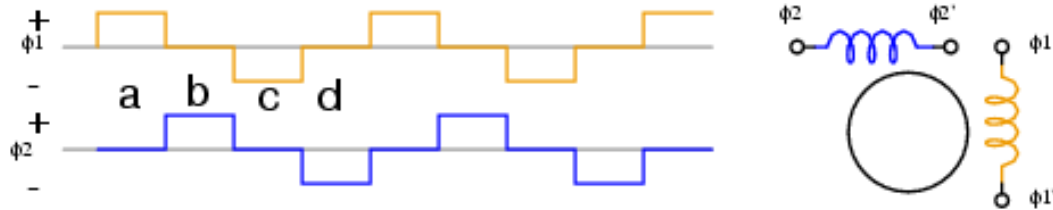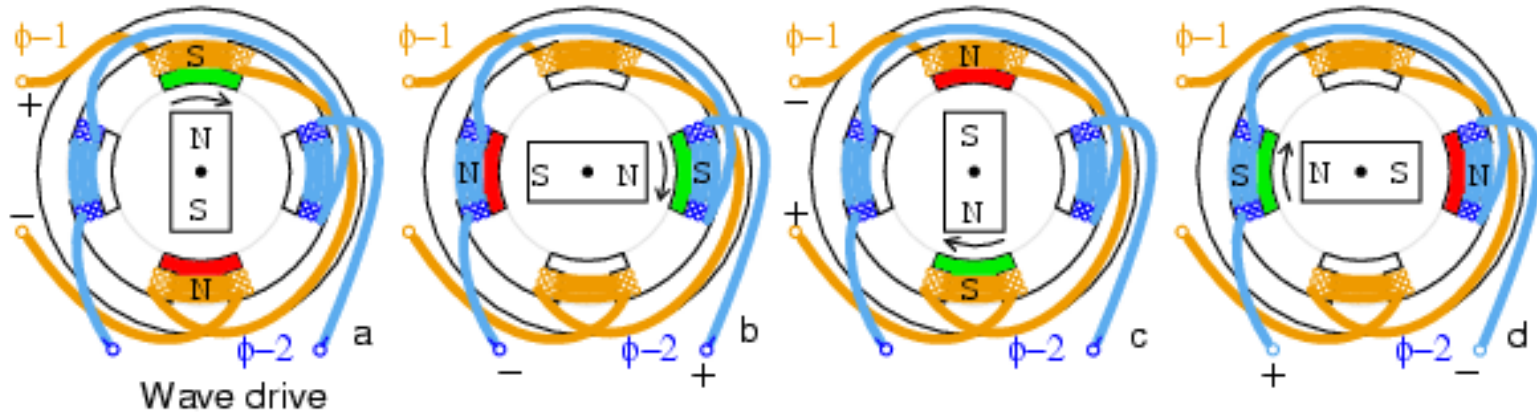- 6V DC & 0.8A

How does it work

Unipolar (2 windings per phase)

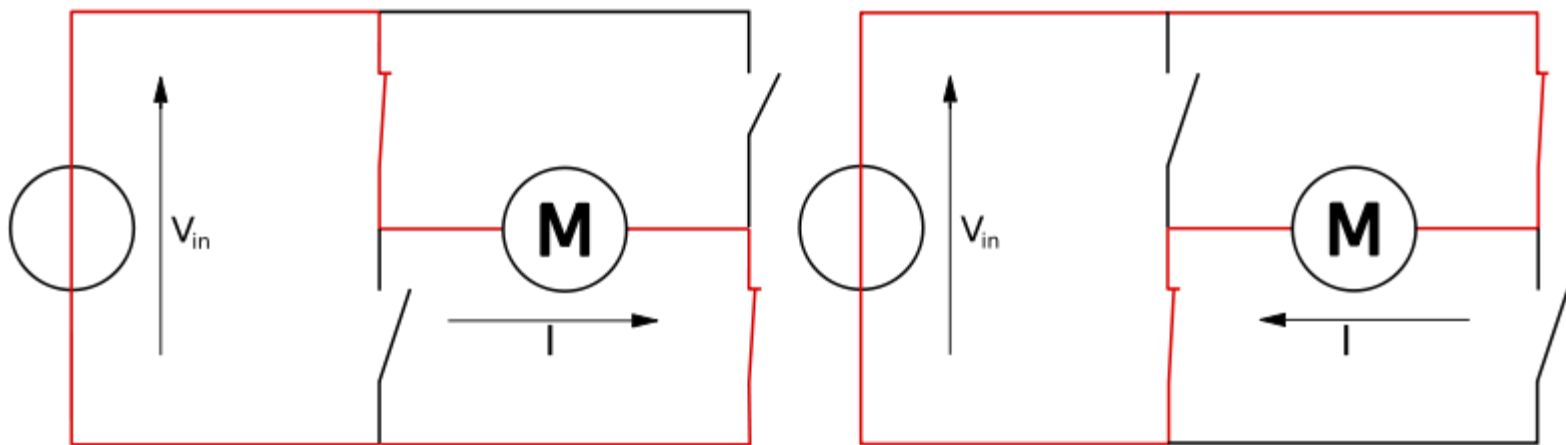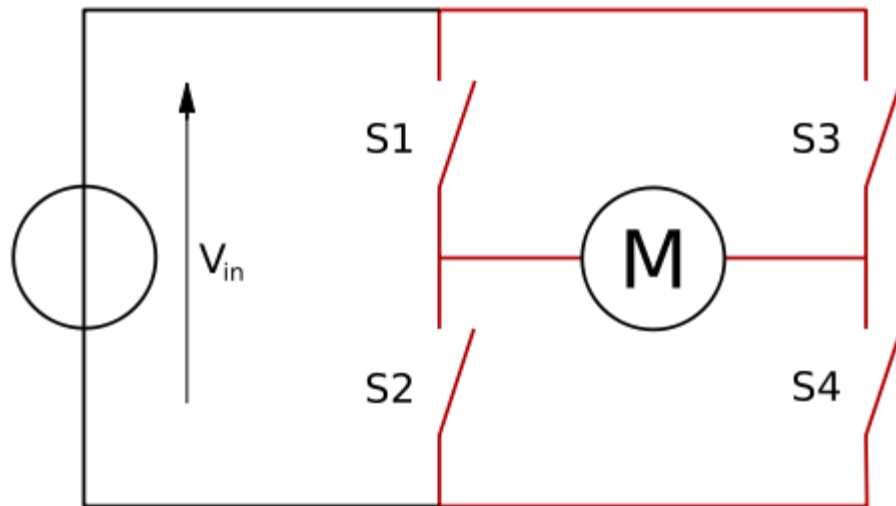Electromagnets turn on and off, causing the teeth on a gear to aligned with the teeth on an electromagnet.
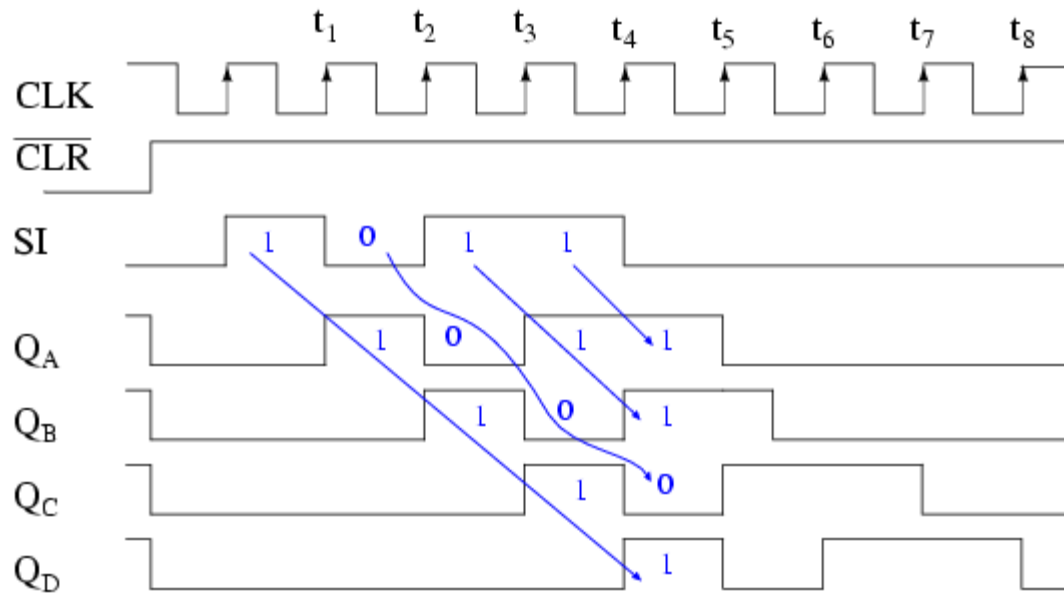
How does it work

Bipolar (One winding per phase)

Bipolar motors have much greater torque but are more complicated to operate becaus
it requires you to reverse the current in the circuit.
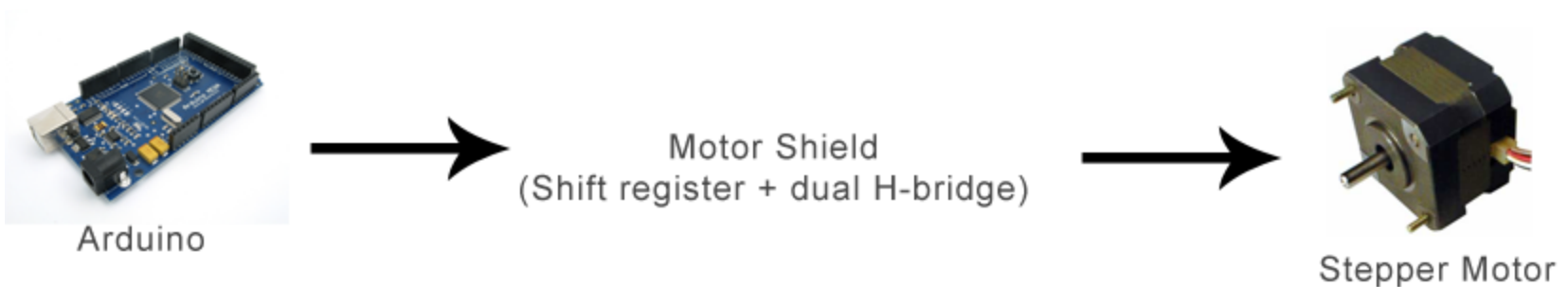
H-bridge

Shift Register

Serial-in, parallel-out

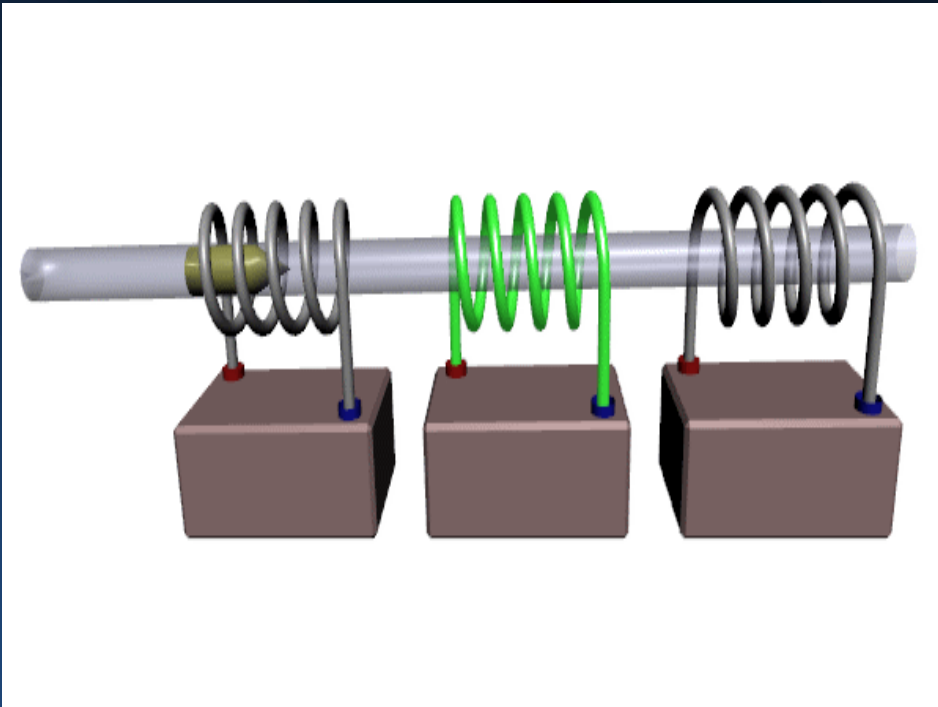Serial-in/ parallel-out shift register waveforms

Motor Control

One step is made up for 4 signals that switch the H-Bridge to active each motor coil in order. Sending the signals in reverse turns the gears in reverse.

```
function left_forward(){
                set pin_5 (coil1);
                set pin_5 (coil2);
                set pin_5 (coil3);
                set pin_5 (coil4);
}

for(i=0; i<=10; i++){
                left_forward();
                right_forward();
}
```

Coil gun

- Coil of wire around a hollow non magnetic tube creating an electromagnet

- A large pulse of current is sent through the coil

- It pulls a magnetic projectile towards it then, when the pulse ends, it turns off and the projectile keeps moving forward.

Coil gun continued (parts)

- Disposable cameras

- SCRs (Silicon-controlled rectifiers): SCRs are basically transistors that, once turned on, get stuck on until the current through them stops, even if you remove the gate voltage.

- Low value resistors (value too low means long charge time, value too high means loss of power to resistors when firing)

Sonic Range Finder

- Consists of a microphone and a speaker

- Sends out a "ping" and counts the delay for the ping to be reflected back

- If the delay is small enough it causes an interrupt in the movement commands to prevent the robot from running into walls

- Arduino libraries already exist

Other Applications

- Brainwave controlled wheelchair
- Video games
- Computer control for the disabled
- Military

Questions ???