

# USB Interface for Haptic-Paddle

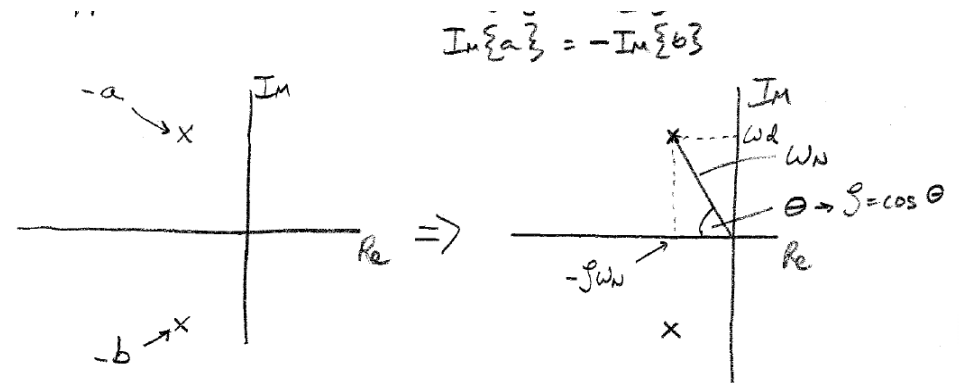
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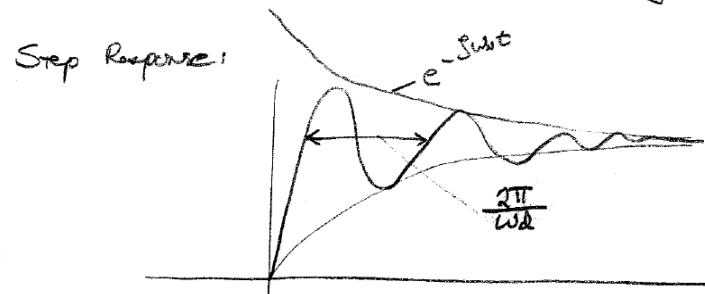


# Haptic Paddle Educational Roles and Objectives

- “Tangible Dynamical Systems”
- Students can feel
  - Damping
  - Inertia
  - Stiffness
  - Resonance



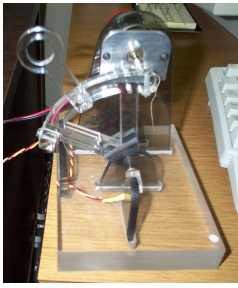
$\omega_n$  : Magnitude of cc pole } → Natural Frequency  
 $\zeta$  : cosine of angle } → Damping Ratio  
 $\omega_d = \omega_n \sqrt{1 - \zeta^2}$  } → Damped Natural Freq



$$1 - e^{-\zeta\omega_n t} (\cos(\omega_d t) + \phi)$$

# Objectives (2)

- Active Learning in Haptics Engineering
  - **Build** the haptic paddle
  - **Program** haptic effects
  - **Trade off** design parameters
  - **Evaluate** human responses
  - **Design** improvements and tweaks



# Low Cost Alternatives



- **Haptic Paddle**
  - 1 DOF
  - \$150?
  - *Low level programming and engineering:*
    - *Stability*
    - *Mechatronics*
- **Novint Falcon**
  - 3 DOF
  - \$250
  - *High Level programming:*
    - *Rendering*
    - *Applications*

([www.novint.com](http://www.novint.com))

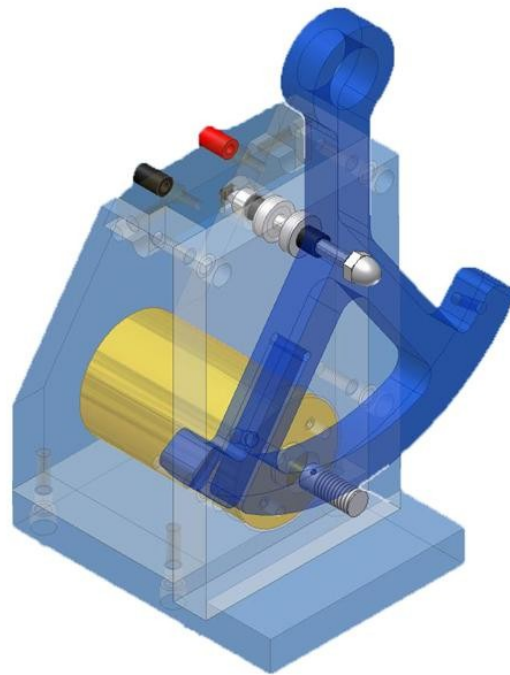
# Stanford Haptic Paddle 2002



A. Okamura, C. Richard, M.R. Cutkosky, "Feeling is Believing: Using a force feedback joystick to teach dynamic systems, ASEE Journal of Engineering Education, v91, n3, pp 345-350, 2002



Utah Haptic Paddle

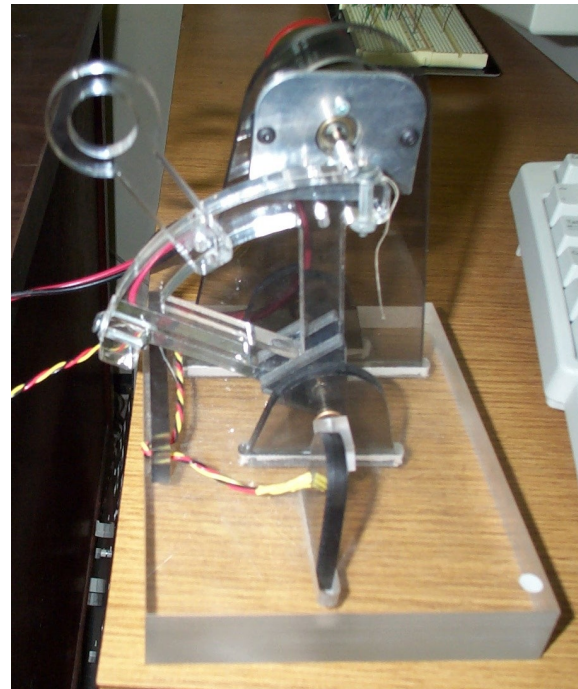


Rice Haptic Paddle



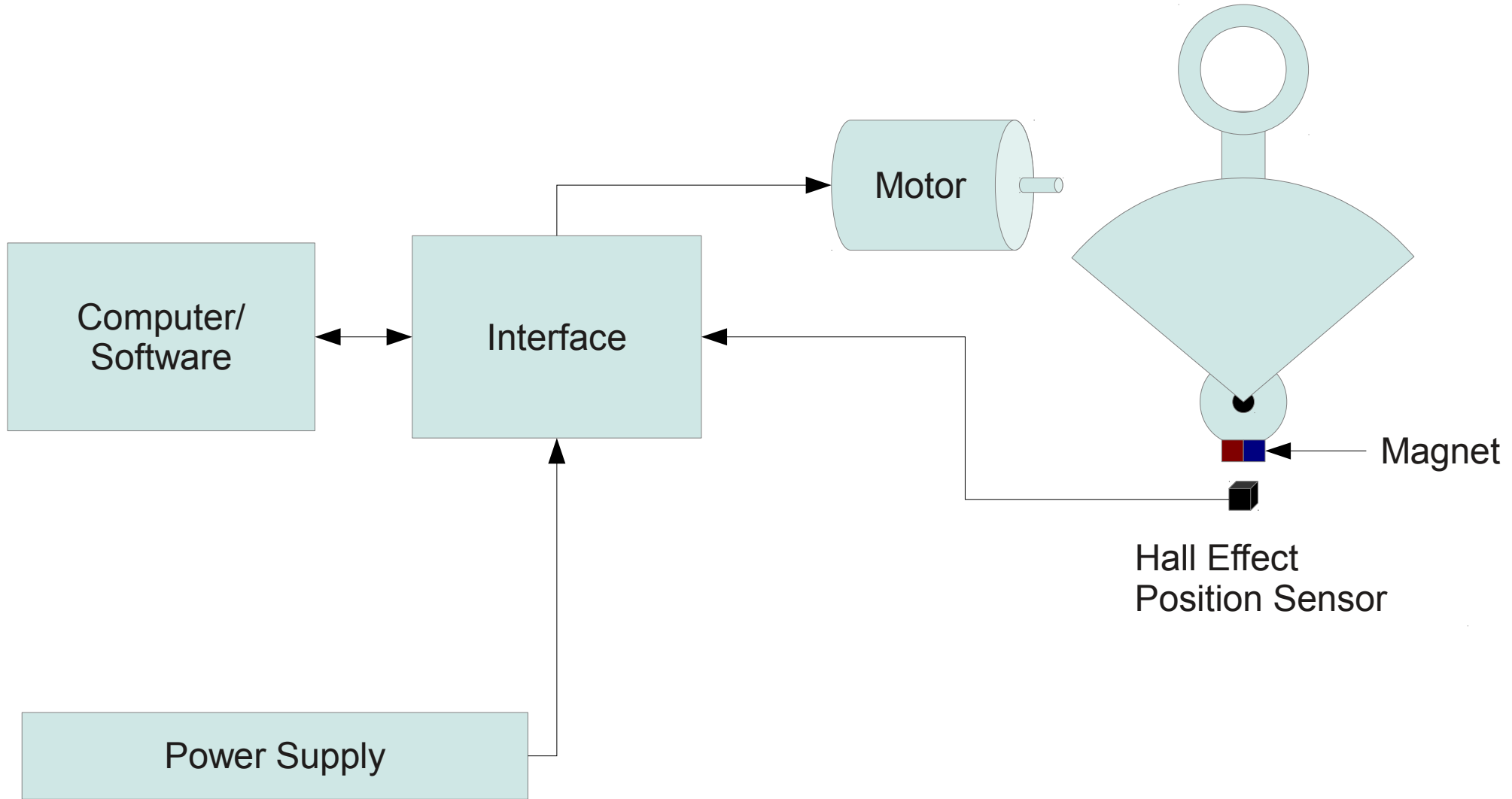
© R.B. Gillespie

Michigan Haptic Paddle



Hopkins Haptic Paddle

# Haptic Paddle System





# *Problem*

- Original Haptic Paddle interface used PC printer port ... a “legacy port”



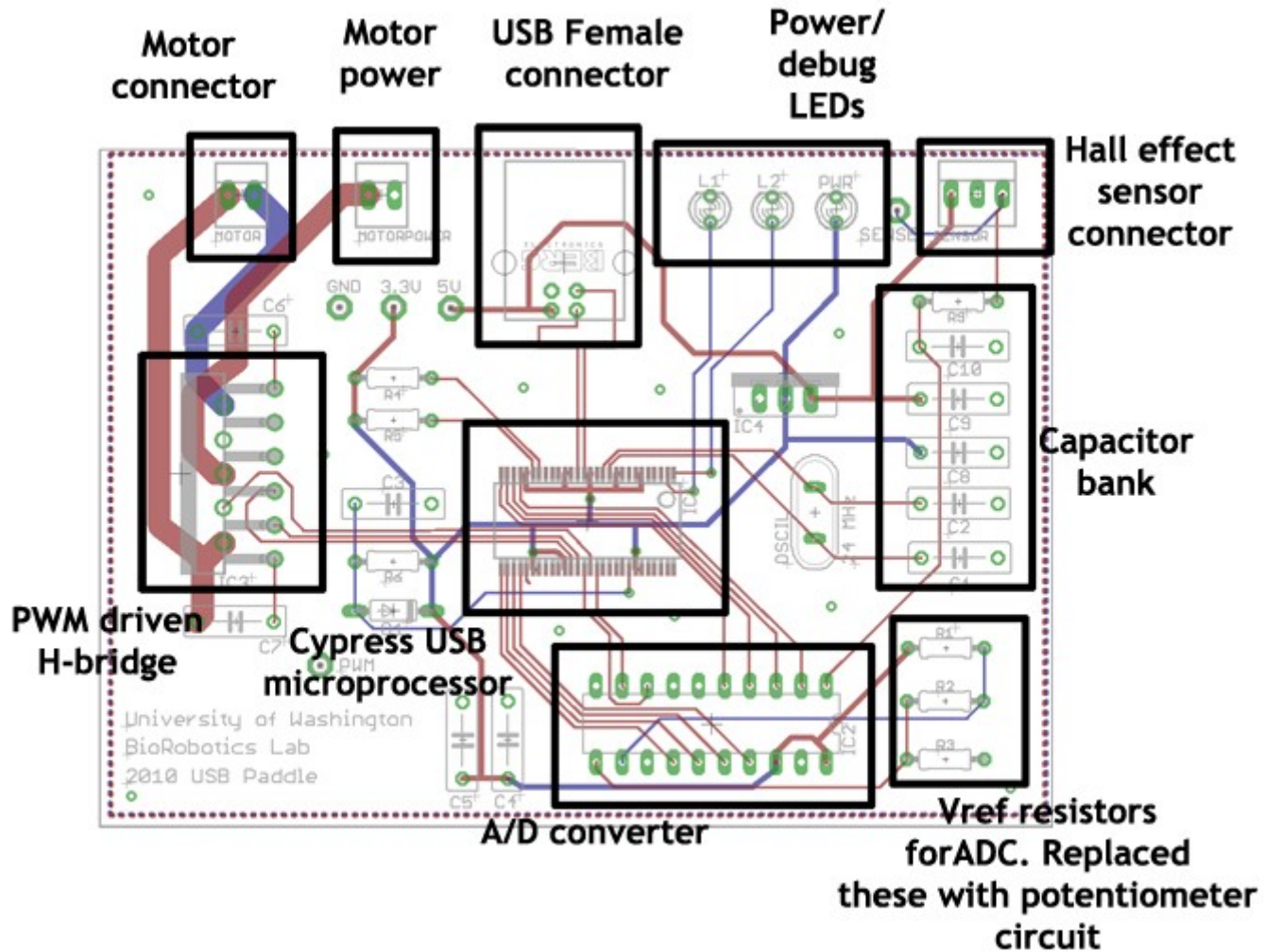
# *Solution*

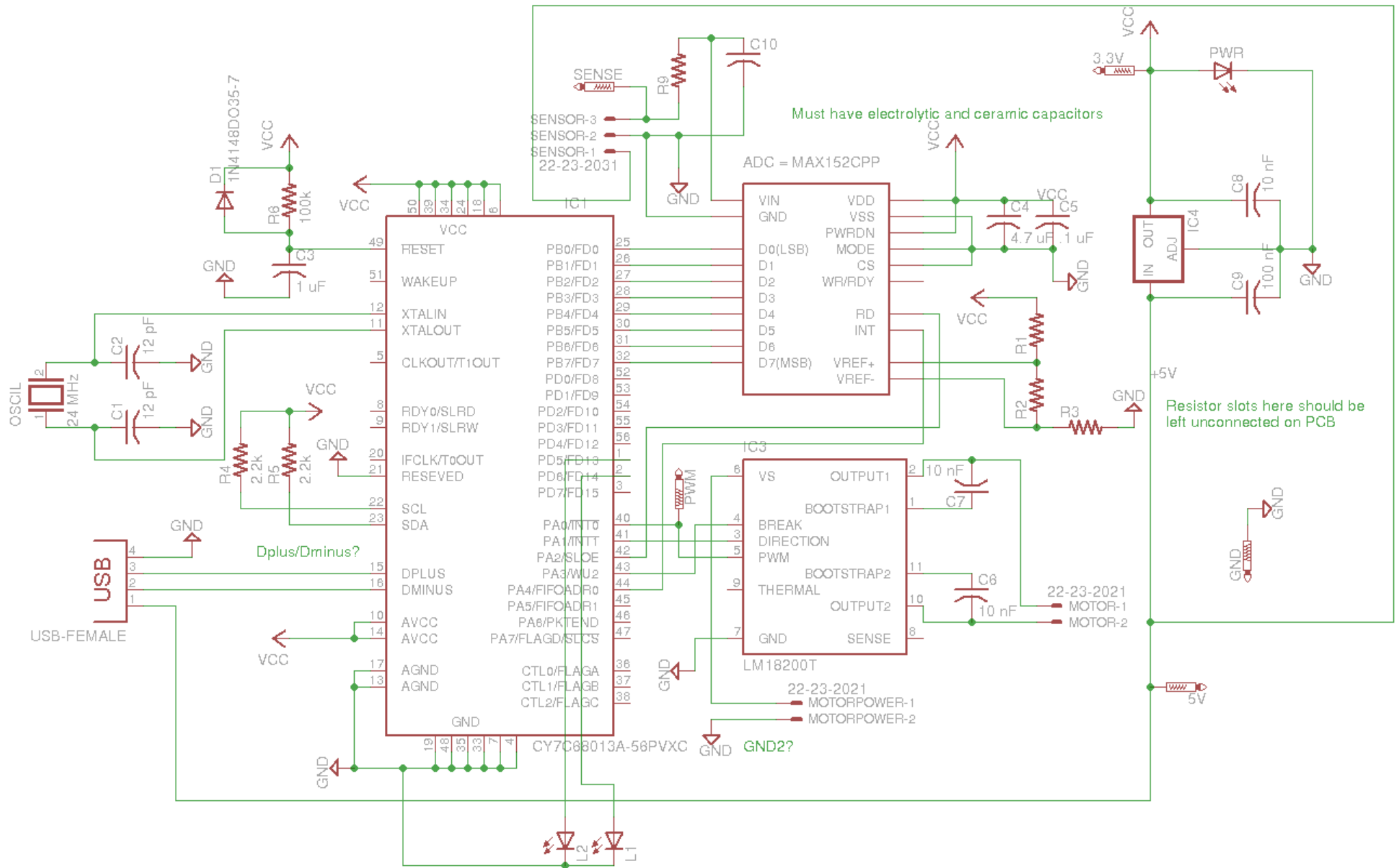
- Design a new USB interface

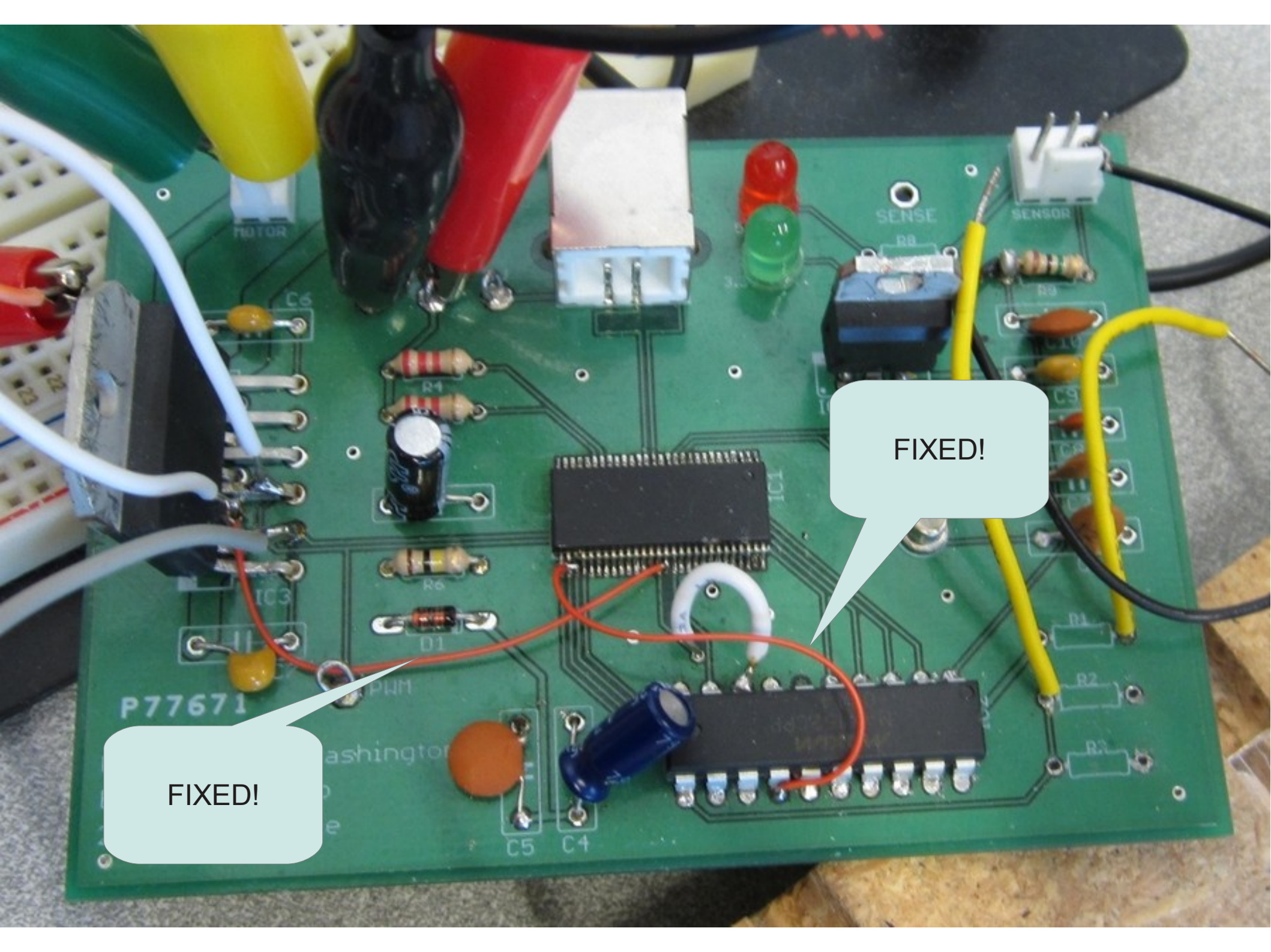




- USB haptic paddle interface board



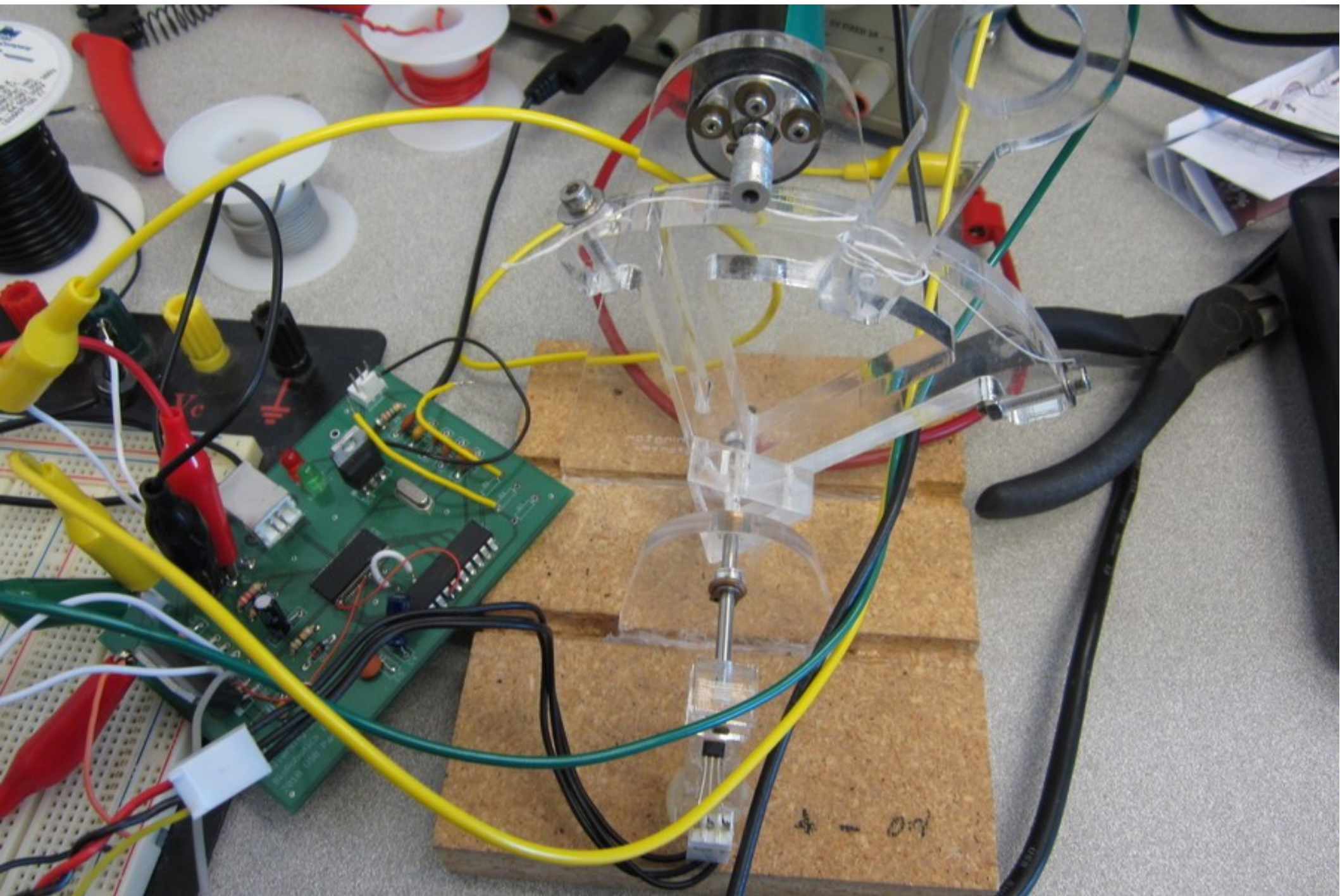




FIXED!

FIXED!





# Features

- Cypress USB microcontroller CY768014A
- 8-bit analog to digital converter MAX152
- H-bridge motor driver LM1800T
- USB connection to Windows Vista/7
- LEDs for debugging output

# Software Requirements and Info

- Windows Vista or Windows 7
- VisualStudio 2010 – IDE for developing host PC control software
- Cypress drivers
- Full Information and download site:

<http://brl.ee.washington.edu/laboratory/node/25>

# Sample Program

```
void main()
{
    ... initializations ...
    //Initialize the MM timer to have a 1 ms callback
    MMRESULT mmTimer;
    timeBeginPeriod(0);
    mmTimer = timeSetEvent(1, 0, TimeProc, NULL, TIME_PERIODIC);
    ...
}
```

TimeProc ( ) is your control callback



# Sample Program (pt 2)

```
void CALLBACK TimeProc(... params ...)  
{  
    ... declarations ...  
    // check for user keypress ("escape")  
    ...  
    // start asynchronous IN transfer from USB  
    >     inOvLap.hEvent = CreateEvent(NULL, false, false, L"CYUSB_IN");  
    >     UCHAR *inContext = USBDevice->BulkInEndPt->BeginDataXfer(bufferIn, length, &inOvLap);  
    >     USBDevice->BulkInEndPt->WaitForXfer(&inOvLap, 1);  
    >     CloseHandle(inOvLap.hEvent);  
  
    currentAngle = (posToAngle((int)bufferIn[0]));  
    penetration_depth = wall-currentAngle;  
    if(penetration_depth < 0) { penetration_depth = 0 };  
    //Motor output should be an integer between 0 and timerWidth  
    motorOutput = (int)(gain*penetration_depth); // 0-255 PWM value  
    buffer[0] = motorOutput; buffer[1] = torque_sign;  
  
    //Asynchronous OUT transfer  
    >     outOvLap.hEvent = CreateEvent(NULL, false, false, L"CYUSB_OUT");  
    >     UCHAR *outContext = USBDevice->BulkOutEndPt->BeginDataXfer(buffer, length, &outOvLap);  
    >     USBDevice->BulkOutEndPt->WaitForXfer(&outOvLap, 1);  
    >     CloseHandle(outOvLap.hEvent);  
  
    >  
}
```

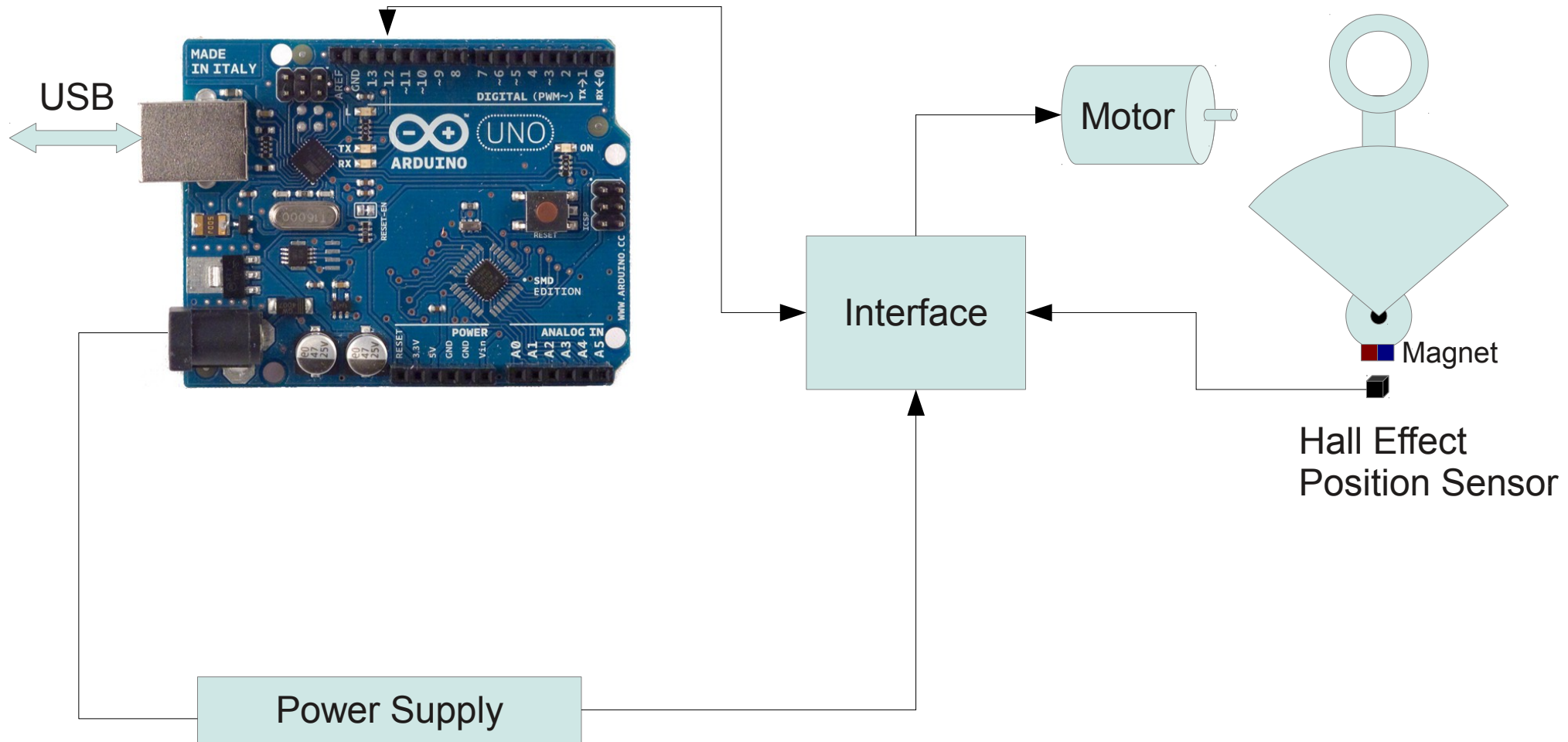
# Optional Microcontroller Development

- Cypress CY3684 FX2LP development kit
- Keil uVision – IDE for developing firmware in the Cypress microcontroller (included)

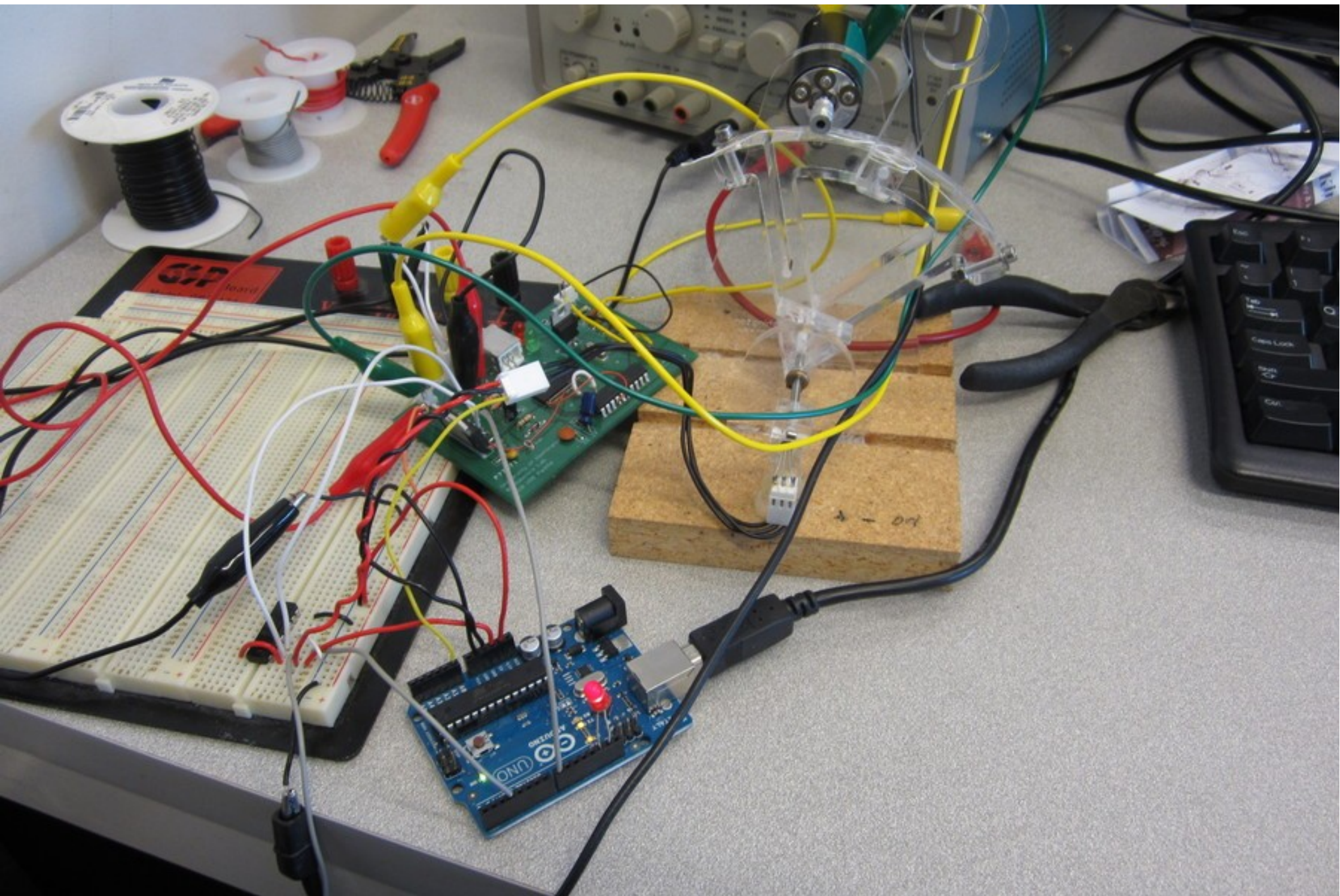
([www.keil.com](http://www.keil.com))



# Coming Attraction: Arduino







# Arduino Advantages

- Open source hardware and software
- Vast developer community and software ecosystem
- \$30 + cost of interface

# thank you ...

<http://brl.ee.washington.edu/laboratory/node/25>

Or just go to <http://brl.ee.washington.edu> and navigate to “Research” / “Haptic Interfaces”