Franklin W. Olin College of Engineering

Real World Measurements Final Project

Mind Rush

A Bio-Feedback Obstacle Avoidance Game in Python, Java, and MATLAB

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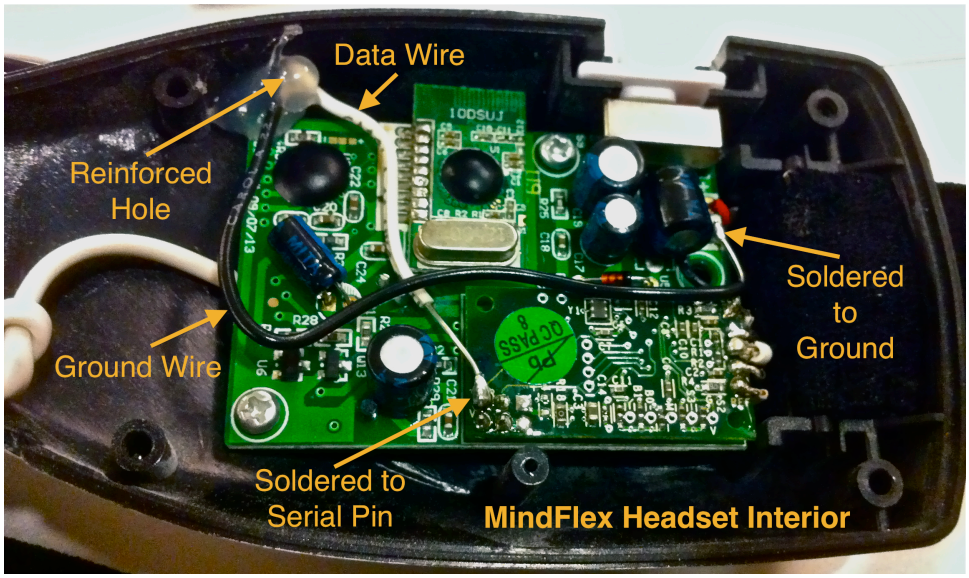


Figure 1: These modifications to the Mindflex hardware allow third party serial hardware to read data from the NeuroSky chip that measures brain activity. The data wire is soldered to the serial pin of the NeuroSky chip and the ground wire shares ground with the Mindflex circuitry.

A Instructions for Replicating the Control System

A.1 Preface

We used a *Dell* E6410 laptop with a Core i7 processor and maxed out RAM running Windows 7 (32 bit). It should be possible to use other operating systems and hardware, but the instructions we have provided are tailored for the platform we used and will need to be modified for other platforms. That said, each of the following sections can stand by itself–it is possible to control the game using the keyboard alone or with only one of the bio-feedback systems in use.

A.2 Mindflex Hack and Software

Prerequisites

This section requires a working Mindflex headset and a Sun SPOT. Although we used a Windows machine for the final control system, we initially set it up on a 15-inch Macbook Pro from late 2008 running Mac OS X version 10.6.7. However, the procedure for installing the Sun SPOT development platform on this computer was significantly different from the procedure described below.

Hardware Hacking Procedure

Follow Eric Mika's hacking guide [**?**] until your hardware has been modified to look like that in figure **??**. The headset can be connected to a Sun SPOT by connecting the serial cable to the Sun SPOT's `D0` pin and the ground wire to the Sun SPOT's upper `GND` pin.

Software Installation Procedure

1. Go to the NetBeans download page and accept the license agreement on the website. Then click on the Windows download link under the heading *JDK Update with NetBeans 7.0*. Run the installer with the default settings.

2. Go to the Sun SPOT Manager Installation Page and click on the *Install Now* link. Run the downloaded installer. **Choose NO when asked to install the JRE**; choose "yes" to install Ant and the Sun SPOT NetBeans Modules. The installer will now fail. Close it.

3. Set the Ant and Java bin paths by adding

   ```
   ;C:\apache-ant-1.8.2\bin\;C:\Program Files\Java\jdk1.6.0_25\bin\
   ```

   to the `Path` environment variable. Then create a new variable called `JAVA_HOME` Set its value to `C:\Program Files\Java\jdk1.6.0_25\`.

4. Modify the "Sun SPOTManager" shortcut on your desktop to launch the application with Administrator permissions (this option is one of the shortcut's "Advanced Properties").

5. Use the Desktop shortcut you modified in the previous step to re-run the installer. Choose no for every option until you get to the prompt after the one referencing NetBeans Modules. During the SDK installation procedure, the installer will complain about white spaces in path names. Choose "continue", not "change."

6. Make the NetBeans modules install properly by opening NetBeans and adding `http://www.sunspotworld.com/NB6/updates.xml` in the *Tools* $\rightarrow$ *Plugins* $\rightarrow$ *Settings* menu. The "name" field can be set to anything you want. Reload the catalog in the "Available Plugins" tab and install every plugin with the category "SunSPOTs."

7. Change the NetBeans shortcut to launch NetBeans as Administrator–otherwise it will be unable to make some required directories when compiling or running SunSPOT code.

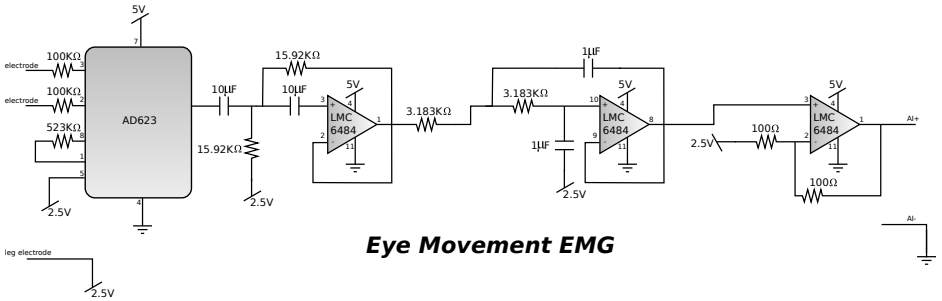
8. Finally, open the NetBeans project in the root directory of the software repository and connect your SunSPOT to the computer via USB or a remote basestation. Compile and deploy the code to the SPOT.

A.3 EMG Circuit and Software

Prerequisites

This section assumes that you have access to basic circuit components, three electrodes[1], and a National Instruments data acquisition device. We used the *NI USB-6009*, but other devices should work as well. It also requires MATLAB and the MATLAB Data

[1] We used Biopac electrodes



Disclaimer: Connect this circuit to a person at your own risk.

Figure 2: Design of the circuit ultimately used to control game movement.

Acquisition Toolbox to be installed. We were unable to run the system on a non-Windows system. If you want to do this, you will probably need to use a different data acquisition device, such as an Arduino, and will need to modify the MATLAB and Python code to support the new device. If we do this ourselves, we will make the code and instructions available as part of our software repository. The software installation instructions assume that you want to use MATLAB to gather data from the device.

Hardware Setup

1. Construct the circuit from figure **??** on a breadboard and connect the NI DAQ appropriately.

2. Connect one electrode to your ankle and the other two to your temples. The latter two electrodes should each be as close to your eyes as possible so that they can read eye muscle movements properly. **Important Safety Warning**: Before connecting the device to a person, be certain to test it thoroughly and make sure that the circuit is not powered (directly or indirectly) from a wall socket.

3. Connect the NI DAQ to a battery-powered computer and use alligator clips to connect the circuit to the electrodes.

Software Installation Procedure

1. Install Python 2.6 and make sure that your `Path` environment variable contains the path to the Python runtime. In our case, we had to add `;C:\Python26\` to the variable.

2. Download a C++ compiler compatible with the `pymatlab` Python module. We used Visual Studio C++ 2008 Express Edition and ran vcsetup.exe with default options except for the option to install the optional SQL Server 2008 Express Edition Box and the one to allow Visual Studio to receive and display online RSS content.

3. Download and run "setuptools-0.6c11.win32-py2.6.exe" from the Python Setup Tools install page.

4. Download pymatlab-0.1.3-py2.6-win32.egg from the Pymatlab Install Page.

5. Add `;C:\Python26\Scripts\` to your `Path` environment variable.

6. Open cmd.exe and navigate to the directory where you downloaded the pymatlab ".egg" file. In our case, the command to do this was `cd C:\Users\jceipek\Downloads`.

7. Execute the command `easy_install pymatlab-0.1.3-py2.6-win32.egg`. Wait while the installer installs various necessary components such as numpy. Ignore the errors.

8. Add `;C:\Program Files\MATLAB\R2010b\bin\win32\` to your `Path` so that Pymatlab can execute MATLAB commands.

9. Close all open cmd.exe instances and open a new instance.

10. Test out Pymatlab by following the following procedure:

    (a) Open the Python interpreter by typing `python` at the prompt.

    (b) Type `from pymatlab.matlab import MatlabSession`

    (c) Type `session = MatlabSession()` to open a new MATLAB command window.

    (d) If the previous step succeeded, Pymatlab is successfully installed. Use `session.close()` to close the session.

A.4 Game

Software Requirements

The game requires python 2.6 (although it may work with other versions) and Pygame, which can be downloaded from the http://www.pygame.org/download.shtml. At this point, it can be run by opening a command prompt window, navigating to the root directory of the software and executing `python mindRush.py`. The game can then be controlled with the keyboard (the arrow keys and the space bar). Pressing `Esc` will close the program.

Enabling the Mindflex Input Device

To enable the Mindflex device, modify the `#Debugging Globals:` and `#Identifiers:` sections in mindRush.py so that `enableMindFlex = True` and the `SunID` matches the string on the sticker on the back of the Sun SPOT.

Enabling the EMG Input Device

To enable use of the EMG circuit, modify mindRush.py such that the line `enableEyeCircuit = False` reads `enableEyeCircuit = True`. You can then connect yourself to the EMG as described in section **??**.

References

[1] http://frontiernerds.com/brain-hack