MicroMedic Project Report

Neuro

by the LWD Robot Club

Executive Summary

Our project entry is an inexpensive device used to conduct a quick neurological field assessment of a subject who may have sustained a brain injury.

It does this by giving the subject a series of tasks to perform and measuring their responses by reading load cells, timing the task, or comparing the subject's answers to questions with the correct answers. The tests can be done in less than three minutes.

This device could be useful for detecting concussions in soldiers exposed to blast effects and athletes who have suffered head impacts, detecting impairment in suspected stroke victims, and even detecting neurological impairment in scuba divers who may be suffering from decompression illness.

List of Assessment Tasks

Task1: The subject is presented with a list of three words to remember. The subject will have to recall these words in task 3.

Task 2: the subject will have to drag a shape on the screen into an outline of the shape to test hand-eye coordination. This will be times. If the subject fails to complete the task in a specified amount of time, the system will move to the next task.

Task 3: Click check boxes by the words from task in in a list of words.

Task 4: Grasp two handle bars mounted on the device and push inward. The handle bars depress load cells to measure the force applied. If the left and right side are significantly different, it might indicate trauma to one hemisphere of the brain.

Task 5: Similar to task 4 except handle bars are pulled apart.

Task 6: Similar to task 4 and 5, except the subject squeezes brake levers to test grip strength.

Task 7:   Depress a large knob simultaneously with each hand. This is similar to the handle bar tests but tests the subject's ability to push down.

Task 8: There are buttons mounted on the sides of the console, one on the left, one on the right. There is a light above each button. The subject must push down on the button when the light above the button illuminates. The reaction time is measured.

System Description

The system consists of :

Case. We used a scrap case, but a Pelican case would cost about $50.

12 volt Battery with 5volt USB output (to power the Raspberry Pi), $30.

Removable handle bars, $50.

Bicycle brakes, $50.

Raspberry Pi microcontroller, 512K, Ethernet, 2 USB ports, HDMI 1080p video, Linux based, $35.

WiFi USB port dongle, $11.

ADC Pi board that piggy backs on Raspberry Pi with 8 analog to digital conversion channels, $30.

Eight load cells that can measure loads up to 50 Kg, $30.

Four INA 2126 instrument amplifier chips, two channels each, to amplify the millivolt signals from the load cells to the 0-5 volt range, $20.

A DC-DC converter that produces -5 and +5 volts for the instrument amplifiers, $20.

A small, 12 volt, HDMI monitor, $100, with touch screen, $150. Optionally a tablet (Android or iPad) with WiFi can be used because the software is a browser based web application. Android tablets are in the $100 range now.

Ambidextrous track ball if no touch screen is used, $20.

Various buttons, knobs, hardware, and LEDs, $50.

The system is battery powered and housed in a small case with removable handle bars for compact storage.

A small screen is attached so the operator and user can see the instructions and step through the assessment tasks.

We used a Raspberry Pi as the micro-controller for the device because of its low cost ($35), large memory (512K), and built in Networking and USB inputs. We used a low cost ($11) Wireless Network dongle to link the device to a network router wirelessly.

The Raspberry Pi runs Linux and has enough memory to run the Apache Tomcat web application server, our application, and the MySQL database.

The Pi is equipped with I2C and SPI hardware interface buses, as well as numerous digital input/output pins. It does not have analog-to-digital converters so we used an 8 channel, 12 bit AdC Pi board that piggy backs on the header pins.

System Videos

Software screen capture: http://youtu.be/x2Xp95IbSBM

Device in Action: http://www.youtube.com/watch?v=b_nSWsNm_eg

System build videos: http://www.youtube.com/watch?v=buXw1EOj68w

http://www.youtube.com/watch?v=g592R_9gl-k

Grip Squeeze Sensor: http://youtu.be/-rvqsgep_e

Load Cell mount: http://youtu.be/KBSC_Yx5mCM

Software

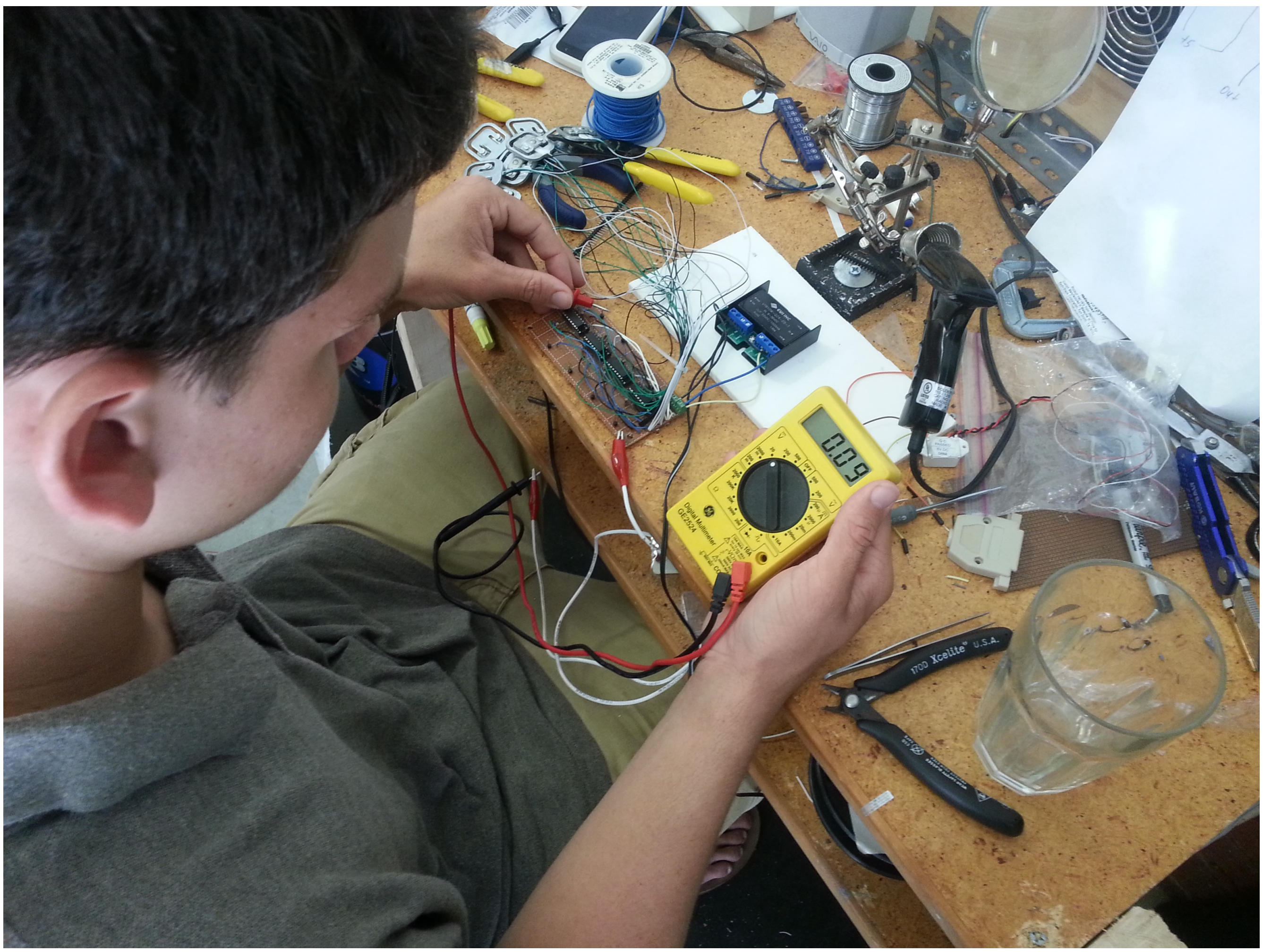
The software consists of a web application running on Tomcat. The software is written as a Java Server Faces application using Facelets for the HTML views. Java code backs the web screens and performs logic, database access, and I2C bus communication to the Analog-to-Digital converters.

The database is the standard MySQL database server with JDBC drivers for Java access.

To speed up the client side execution some JavaScript is used,including some JQuery routines to drag the shapes around the screen.

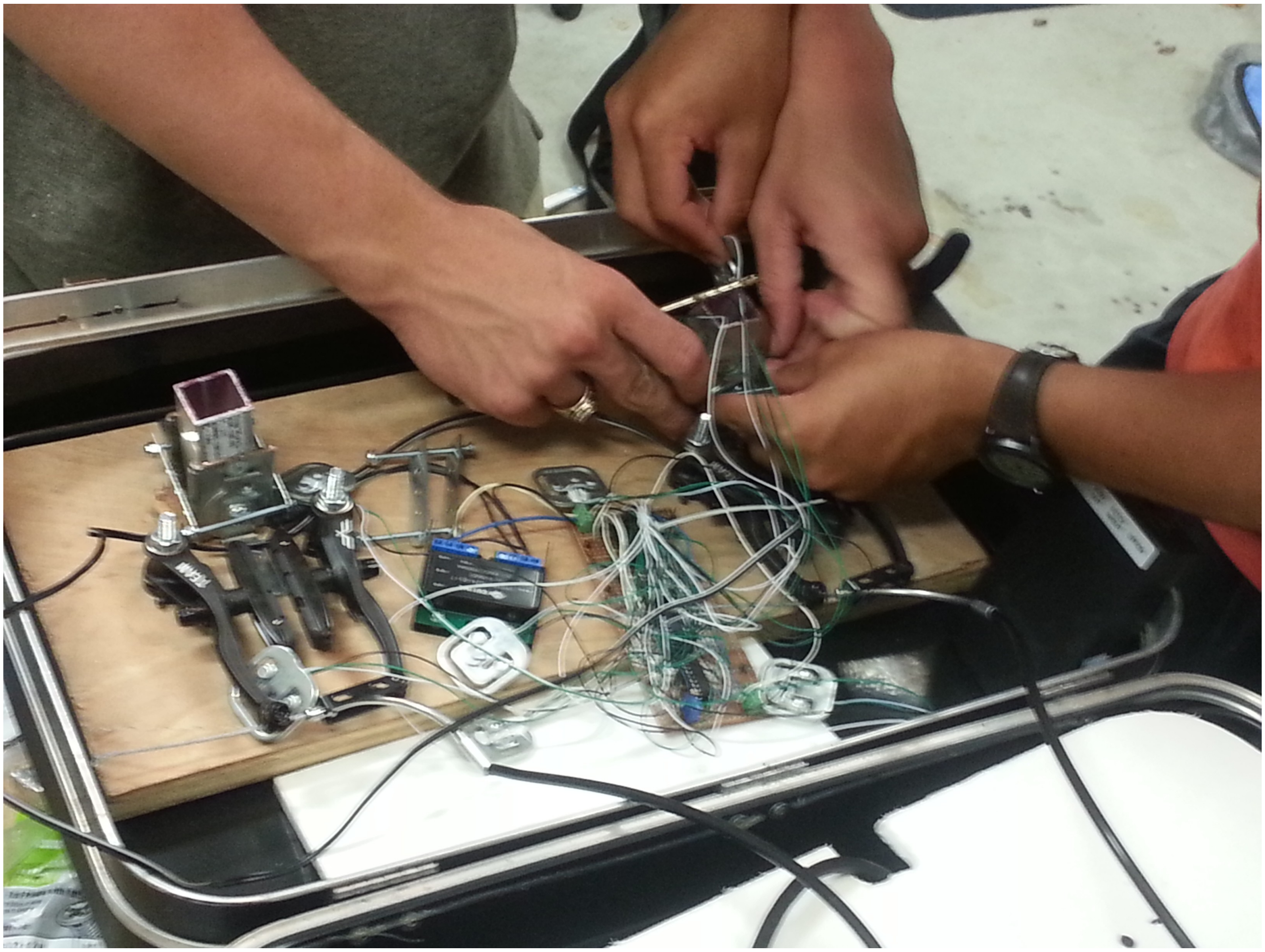
We used the Java 8 early access JDK because it uses the hardware floating point math capability of the Broadcom ARM processor.

Construction Photos

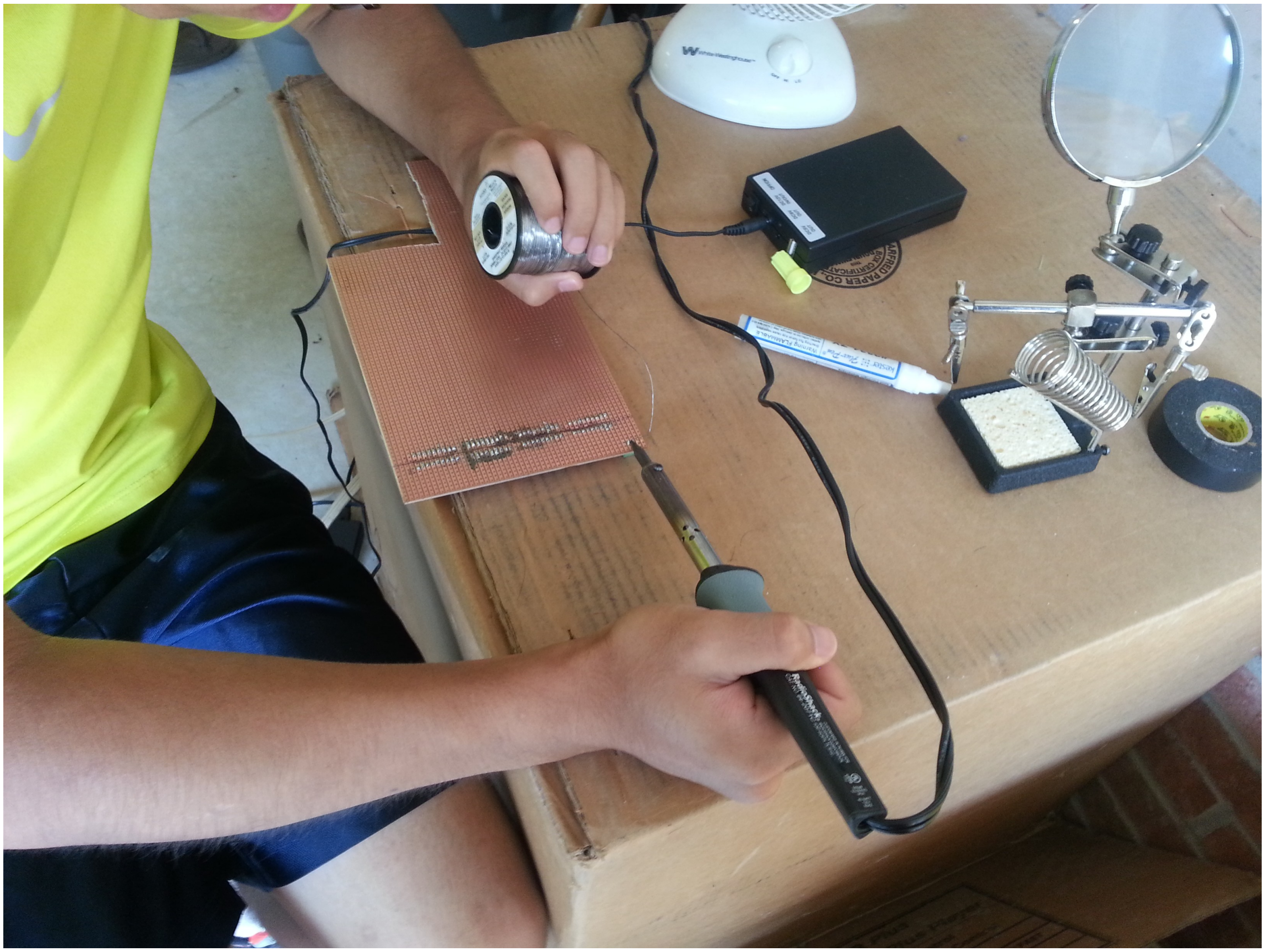


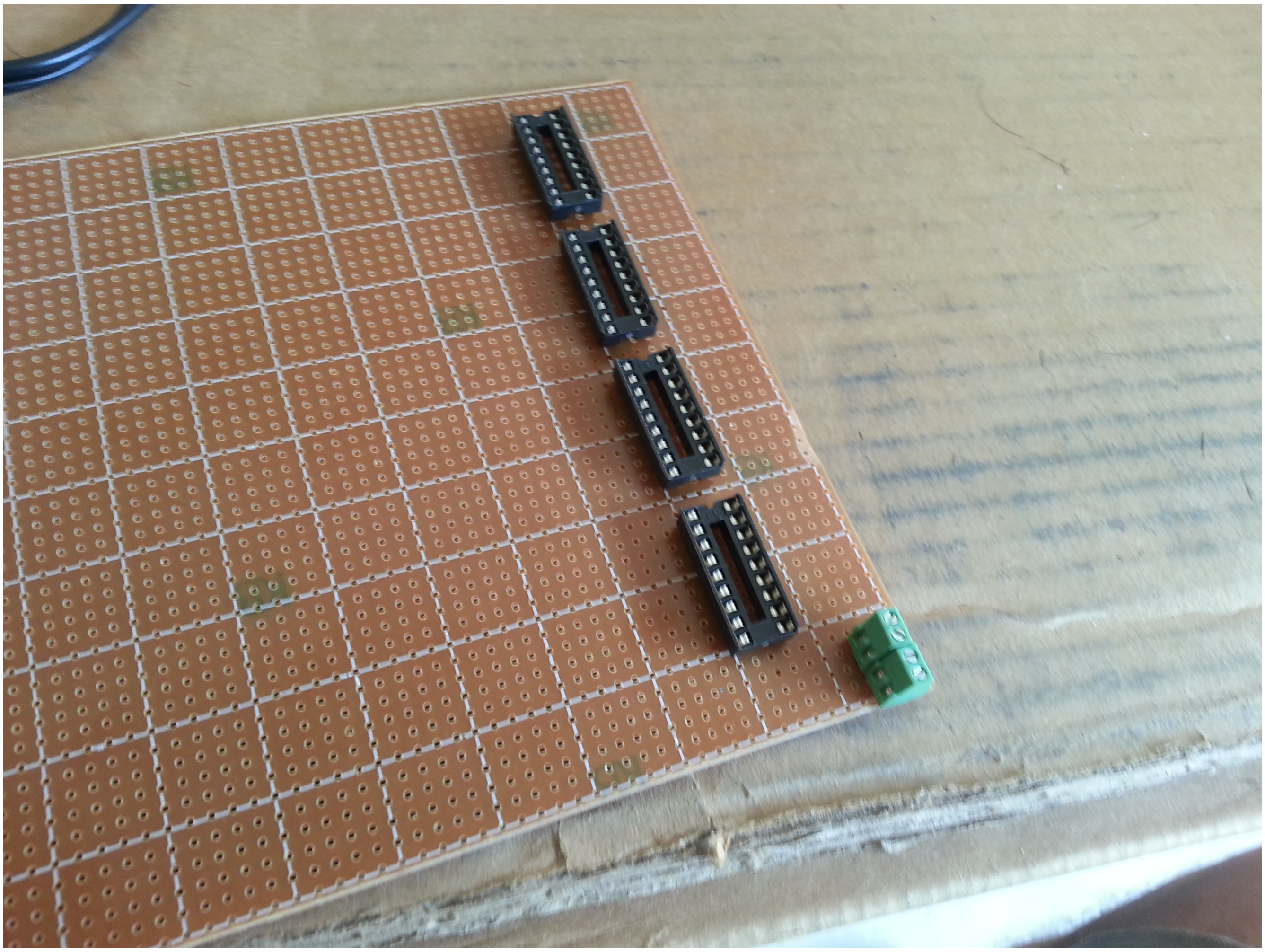
Testing Instrument Amplifiers. DC-DC converter is black box in center. Cluster of load cells by blue wire spool.

System with handle bars removed for storage.



Mounting load cells, amps, handle bars and gripper mechanism.


Soldering sockets for amps.



Amp sockets and power terminals mounted.

Load Cell Diagram