gPod Accessible Blood Glucose Meter

Week 2
January 31, 2006
Matthew Bularzik, David Price, Mike Rivera

Work Completed

This past week the main focus of our efforts was to correct the gain problem within our glucose circuit. The issue was with the electrodes where the voltage signal from working electrode 1 was half that of the voltage signal from working electrode 2. Most of the week was spent trying to figure out that problem. Figure 1 shows a glucose measurement where the signal from working electrode1, in orange, has half the voltage of the signal from working electrode 2, in blue.

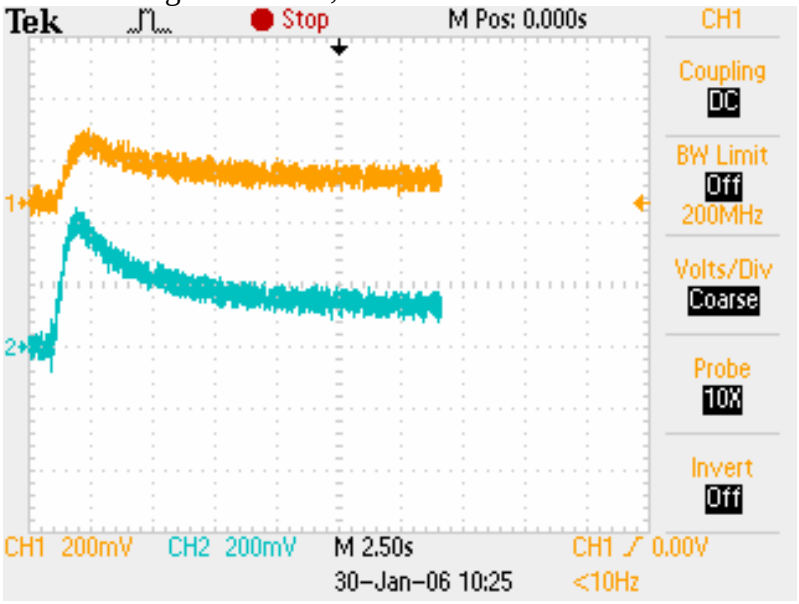

Figure 1, Output voltages.

First we looked into the op-amp circuits to check for connection errors and found no mistakes. The op-amps were replaced with new parts to eliminate the possibility of a damaged op-amp. The circuit was also moved to another location on the protoboard to rule out a damaged section on the protoboard. The voltages measured on the scope were checked for accuracy with a DMM. New scope probes and scope were used to rule out measurement error. A different protoboard was also tried. To confirm that the circuits were operating with the intended gain, a constant current source was used as the input to the circuit. All of the tests confirmed that the circuits were working as intended, but the outputs were still incorrect. We then tried reverting back to the original configuration with the LM741 op amp as opposed to the LM358. The LM358 was used to try and eliminate the need for use of +5/-5 voltages to be used and instead use +5/0 voltages. The same problems persisted with the original set up. The only noticeable and currently untested element of trouble is a difference in the input voltages between the two current-to-voltage converters. A difference of about 1.4mV was observed and more tests run by Mike and Matt will work next week to solve this problem

Then we started to suspect that the electrodes themselves might be the issues with all the use they had been receiving in a short time. Mike went and constructed new electrodes out of some foam tape, wires, and part of a plastic ruler as the base. These new electrodes had the exact same result as the electrodes that were pulled from the meter.

Mike researched information on creating glucose solutions to be used to create a glucose curve. These solutions, ranging from very low to very high concentrations, will be used to formulate the voltage glucose curve that the microprocessor will be using. At present, sample output curves are obtained by using the Lifescan control solution which has a reading of about 114 mg/dL. This control solution can also be diluted to concentrations less than 114 by adding drops of deionized water. By verifying the diluted value with the bought meter, I can make and test any concentration of glucose under 114 mg/dL.

Solutions available for use in hospitals offer three different levels of glucose concentration. Based on the concentration of glucose, there are High (0.35 %), Normal (0.10 %), and Low (0.04 %). The glucose that these solutions use is D-Glucose which is the natural form of glucose also known as dextrose. Other ingredients include a large percentage of Polyvinylacetate, sodium benzoate, and a viscosity adjusting agent. However, in the owner's booklet for these solutions it says that they can only be used with the OneTouch, OneTouch II, and OneTouch Hospital meters. The meter we have is the OneTouch Ultra. But, when comparing the ingredients of these controls to the control that is offered for the Ultra, there is no significant difference.

Another option is to purchase raw dextrose and work from there. Dextrose can be bought as a powder for around a dollar per pound, which is very cheap. If the other ingredients in the manufactured solutions are not essential, we can make glucose solutions of all possible concentrations, with no limitations. This method may prove to be less wasteful as well. When using water to make a diluted sample from the Lifescan control, it requires two test strips each time. One is used to see what the new glucose level is on the meter, and the other to collect the output data from our circuit. If our meter is to be accurate from a range of 20-350 mg/dL, that would require at least 50 test points which is a minimum of 100 test strips. At about a dollar a piece, this can become a very expensive experiment. On the other hand, if we use measured amounts of pure glucose, it may be possible to calculate what the concentration is for a given solution. Not having to test each solution with the meter first can save money as well as time on the whole experiment.

Future Work

Mike will work with the glucose circuit to obtain the necessary data for the glucose-voltage curve. He will make solutions of known concentrations and take voltage measurements. The data will be analyzed and interpreted for use with the microprocessor.

Dave will work with the analog-to-digital converters in the microprocessor. He will write code to initialize the microprocessor and correctly convert a signal from the glucose circuit.

Matt will work with Mike on the glucose circuit and data analysis as well as prototyping the speech chip circuitry.

Project Review

Progress on the project was slow this week. The troubles with the glucose detection circuit delayed the entire project by a week. Due to the previous weeks successes the project will be basically on schedule. The timeline for the coming week includes the completion of the glucose circuit and successful A/D conversion. In two weeks work on the LCD and speech chip should be into full swing. In addition to the LCD and speech chip, data collection and conversion algorithms will be generated for the glucose detection circuit. Hopefully problems such as the failure of the glucose circuit will be few and far between allowing the project to stay on schedule. Total costs to date are $378.24.

The problems with the circuit were resolved on Monday January 30. Mike and Matt worked with some glucose solutions and obtained the data shown in Figure 2. Figure 2 shows 4 concentrations of glucose, 29 mg/dL, 64 mg/dL, 80 mg/dL, and 114 mg/dL.

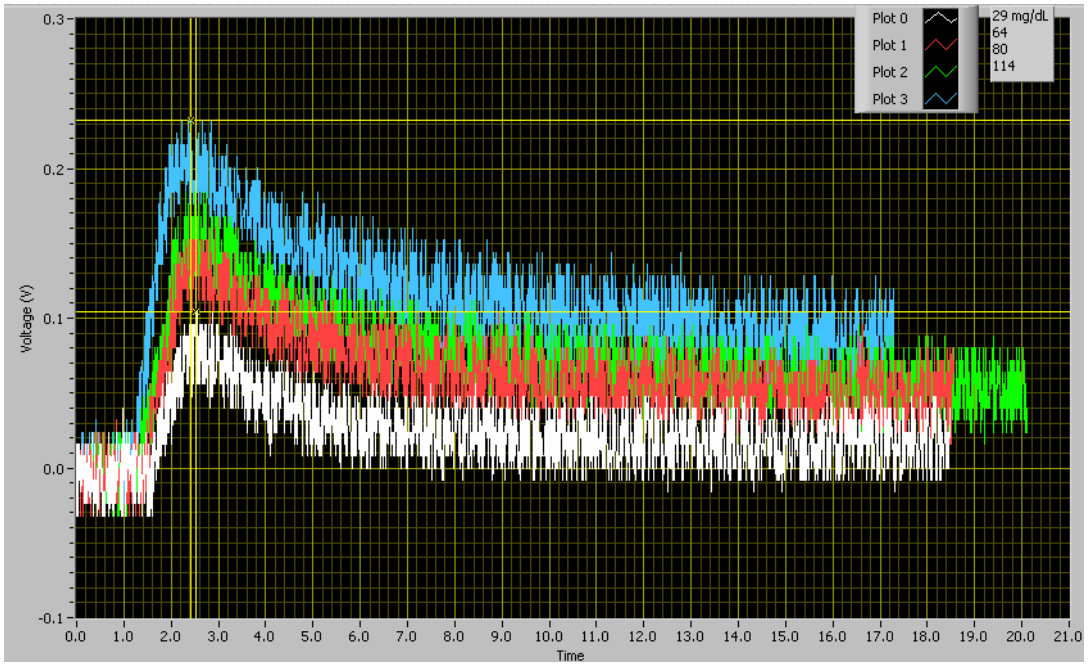

Figure 2, Glucose voltage curve.

Hours Worked

Hours worked on the project: Matt: 14.5 Hours
Dave: 17 Hours
Mike: 8 Hours