gPod Accessible Blood Glucose Meter

Week 9
March 20- 24
David Price

Work Completed

I worked with the glucose-microprocessor circuitry and programming this week. Last week we discovered that the glucose circuit was producing inaccurate readings. The glucose readings were off by at least 40 mg/dL with the old setup. I determined that the analog-to-digital converter was improperly acquiring the voltage data. Our design called for the analog-to-digital converter to acquire a single data point 2 seconds after a threshold of 0.1 volts. This was performed by initializing the A/D and having it run continuously to monitor for the sample. Once this threshold was reached, the A/D delayed measurement for 2 seconds and then printed the result to the LCD screen. The method for this procedure was flawed and the A/D continuously obtained data after the 2 second delay effectively losing the measurement we desired.

The problem was the software was only looking for a voltage over the threshold. Once the threshold was reached the A/D would always be on according to the code. What we needed was the threshold voltage to be detected, send a trigger pulse, acquire data, and turn off the A/D. The solution to this problem is to use a hardware trigger. This trigger works by using 2 comparators set to 2 different voltage levels and an XOR gate. Figure 1 shows the schematic of the trigger.

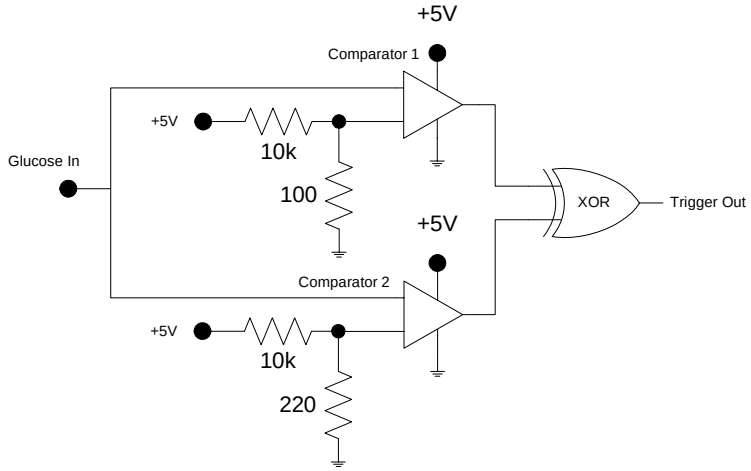

Figure 1, Sample Detection Trigger Schematic.

Comparator 1 is set to detect a voltage of 0.05 V and Comparator 2 is set to detect 0.10 V. When the input voltage goes above 0.05 V but is still below 0.10 volts, the output of Comparator 1 goes high and Comparator 2 stays low. The output of the XOR gate is a high signal indicating the sample. Once the input voltage goes above 0.10 volts both comparator outputs are high and the XOR gate goes low. Once the XOR gate's output goes low the acquisition code initiates in the software. Table 1 shows the possible inputs and outputs of the sample trigger.

Input Voltage	Comparator 1 Out	Comparator 2 Out	XOR Out
0.00	LOW	LOW	LOW
0.05	**HIGH**	LOW	**HIGH**
0.07	**HIGH**	LOW	**HIGH**
0.10	**HIGH**	**HIGH**	LOW
0.15	LOW	LOW	LOW

Table 1, Sample Detection Truth Table.

Initial tests showed that the new trigger and acquisition setup produced much more accurate results when the displayed voltage and scope voltage were compared. Table 2 shows the results of the scope voltages compared to the A/D results.

Trial	Amplitude Meter Result	1V Scope Result	Difference	%error
1	1.470592	1.42	0.050592	3.562817
2	1.431384	1.42	0.011384	0.801690
3	1.392152	1.40	-0.007848	-0.560571
4	1.431384	1.42	0.011384	0.801690
5	1.490232	1.42	0.070232	4.945915
6	1.5098	1.42	0.089800	6.323944
7	1.431384	1.40	0.031384	2.241714
8	1.431384	1.40	0.031384	2.241714
9	1.392152	1.40	-0.007848	-0.560571
10	1.431384	1.40	0.031384	2.241714
11	1.392152	1.40	-0.007848	-0.560571
Average	1.4367	1.4090	0.02763	1.95268
Stdev	0.0393	0.0104	0.03248	2.29149

Table 2, A/D test results.

One glucose trial was run with our meter and compared to the OneTouch Ultra. The OneTouch Ultra showed a reading of 132 mg/dL. Our meter produced a result of 152.7 mg/dL. Figure 2 shows the gPod's results compared to the OneTouch Ultra. Our result is higher than the OneTouch Ultra indicating one of two things. The first reason is our acquisition time is too early. Waiting a period of 3 seconds after the sample is applied may produce more accurate results. Additionally, the glucose-voltage equation may need to be adjusted. Currently the equation is:

Glucose level (mg/dL) = (461*voltage)-19

Adjusting the intercept value of -19 may produce more accurate readings on our meter.

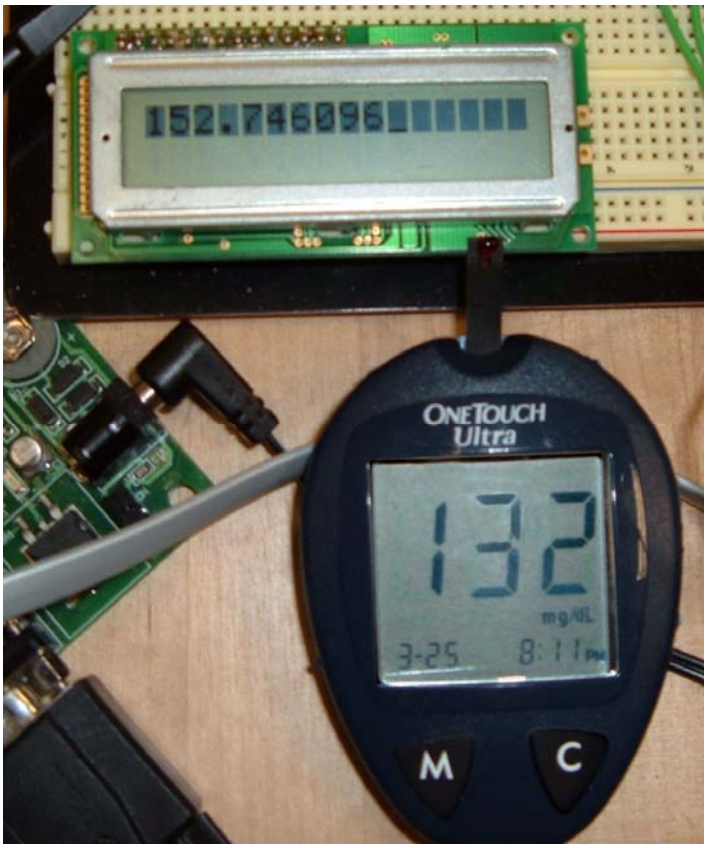

Figure 2, gPod results vs OneTouch Ultra.

Future Work

This week will be spent almost entirely on getting the speech module working with the microprocessor. The code for the RS232 connection required is written and works correctly when tested with the PC. I need to figure out how to format the commands and send them correctly for the speech module to work. Matt will finalize the printed circuit board layout and the final parts order as well as the mechanical layout of the casing. Mike will spend the final week making the glucose measurements as accurate as possible and also work on the vial scanner.

Project Review

The progress on the project was very slow at the beginning of the week. On Saturday, I spent nearly 11 hours working to get the glucose sample trigger and acquisition portion of the project correct. This time spent was extremely productive and I can confidently say that the glucose measurement system and LCD screen work. Total costs to date are $895.67.

Hours Worked

Hours spent on the project for Week 9: **27.5 Hours**