gPod Accessible Blood Glucose Meter

Week 9
March 20- 24
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Work Completed

This week we finalized the glucose circuit, worked with the speech module and vial scanner, and started the printed circuit board layout. Dave made some changes to the glucose detection hardware to ensure better accuracy. Mike worked with the barcode scanner and circuit to start interfacing it with our project. Matt worked on the printed circuit board layout and final parts order.

Last week we 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.

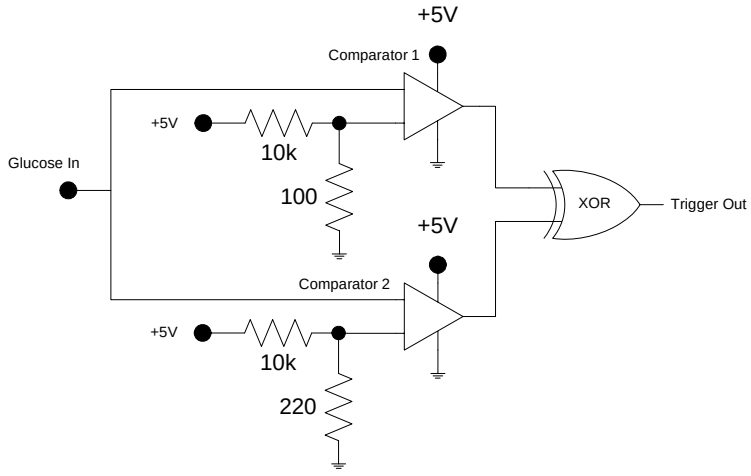

Figure 1, Sample Detection Trigger Schematic.

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 1 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 1, 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 could be that 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.

Matt worked on the PCB board development and circuit layout modifications. He spent a good portion of the week working on the PCB layout with deciding where the board will go in the hand held box and where the many holes should go in the board. The LCD screen will be mounted on the PCB because the mounting holes do not fit the ones on the case. The LCD screen and glucose circuit will be mounted on the bottom of the PCB board so that they will be facing the top of the case. This will allow for the screen to line up with the screen slot and the glucose sensor to be the orientation. Figure 2, below shows the latest PCB board layout with the corners cut out for the postholes.

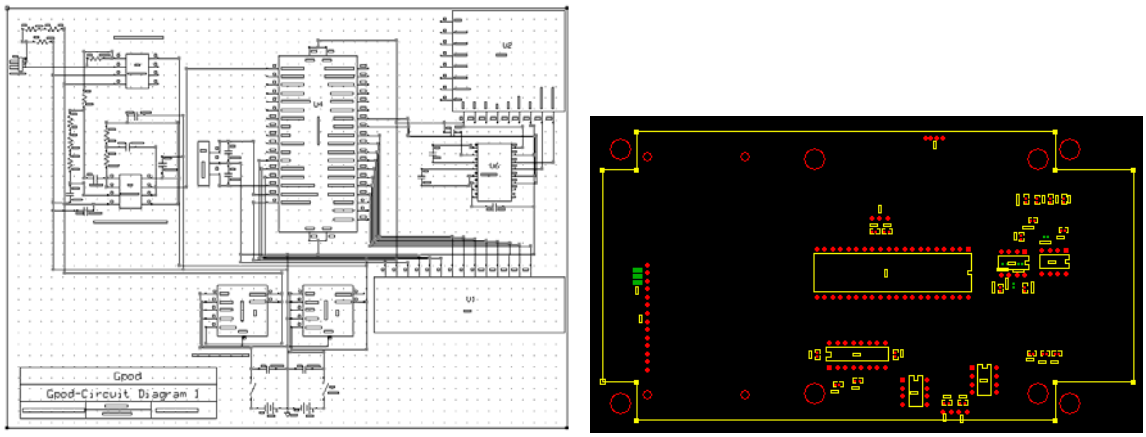

Figure 2: Circuit Schematic and board layout.

Matt also started ordering parts for the final design. The case and its accessories were ordered from OKW. Parts order included a hand held case, a case for the vial scanner, PCB mount screw, PCB mounting brackets, 9V battery leads, and a plastic window.

Mike worked with the vial scanner as well as doing some checks on the accuracy of the glucose measurement. The initial glucose tests showed that our measurements were off by as much as 60 mg/dL. The potential problem was the different batch of test strips. Mike redid some of the glucose curve to check and see if there was a difference between the two sets of strips. After completing the tests and doing the Excel analysis, the glucose curve appeared to be very different. The original equation for batch '2' test strips was Y = 922.23X – 22.903, where Y is the glucose concentration, and X is the voltage at 2 seconds. The new equation for the batch '22' strips came out to be Y = 461.74X – 18.876. These two equations are very different, all more than expected, and could undoubtedly be the reason why the measurements were coming out wrong. Different batches of test strips clearly have different voltage responses to the glucose. The new equation was implemented in the software. We then tried a couple tests using strips to see if that had been the problem.

Mike also worked on the scanner circuit. The scanner uses a USB connection to attach to computers, however our microprocessor has serial capabilities. The circuit that Mike built allowed the scanner to be bus powered, as well as integrated a FT232BM chip for USB to RS232 conversion. Figure 3 shows the circuit built on the proto-board.

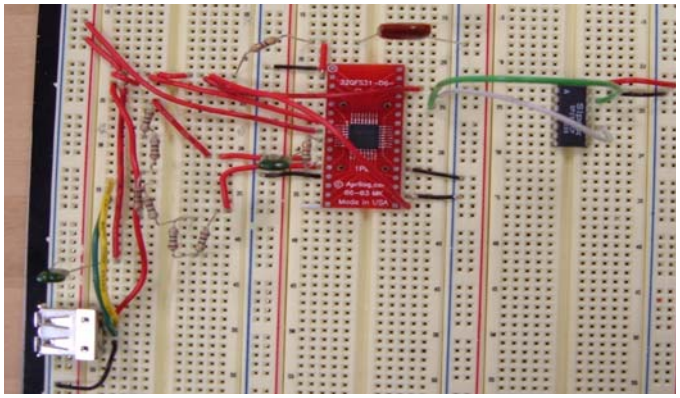

Figure 3, USB circuit on protoboard.

Future Work

In the next week we need to finalize the prototype on the protoboard. The power switch, voltage regulators, new LCD screen, and battery power will be integrated into the design. Work will also be done to improve the accuracy of the glucose measurement and to eliminate any possible error modes. By the end of the week we will have the vial scanner working with the microprocessor. The final PCB layout will be sent out for fabrication and all of the components will be ordered.

Project Review

The progress on the project was very slow at the beginning of the week. On Saturday, Dave 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 we can confidently say that the glucose measurement system and LCD screen work. Work on Monday got the speech module working correctly with the microprocessor and accurately outputs glucose measurements. Total costs to date are $895.67.

Hours Worked

Matt: 30 Hours
Dave: 27.5 Hours
Mike: 18 Hours