gPod Accessible Blood Glucose Meter

Week 6
February 19-25, 2006
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Work Completed

Throughout week 6, Matt worked with both the Winbond speech chip and the SP03 speech module. This was the final week getting the Winbond speech chip circuit to work on its own. The speech chip is the cheaper alternative to the SP03 module which was the reasoning behind using it in our optimal design. To begin, Matt mapped all the pins on the SP03 speech module for the Windbond speech chip to see what the voltage levels on each pin were set to. This was to help him figure out which pins had to be set to 3.3 volts and which pins had to be set to +5 volts. He also tried a new crystal oscillator to see if the speech chip circuit needed one. This was done because the SP03 module uses one, but for the chip this made no difference. Also, a slight variation to the 5MHz resonator circuit was attempted, but still nothing happened. In both attempts the resonators and the crystal oscillators did not generate a signal as they were supposed to. Due to this, he could not figure out how to get the Winbond speech chip to work and therefore had to give up on its construction for time constraint reasons. With that Matt moved on to working solely with the SP03 speech module. The first thing that I did was to map out what exactly was on the SP03 speech module to get a better understanding.

The SP03 speech module circuit consists of:

- A Winbond speech chip which generates the text-to-speech capabilities
- PIC16F872 microprocessor
- STS232 for serial connection
- LM386 which is an audio amplifier
- 2 oscillators
- A voltage regulator
- A variety of resistors and capacitors
- A speaker

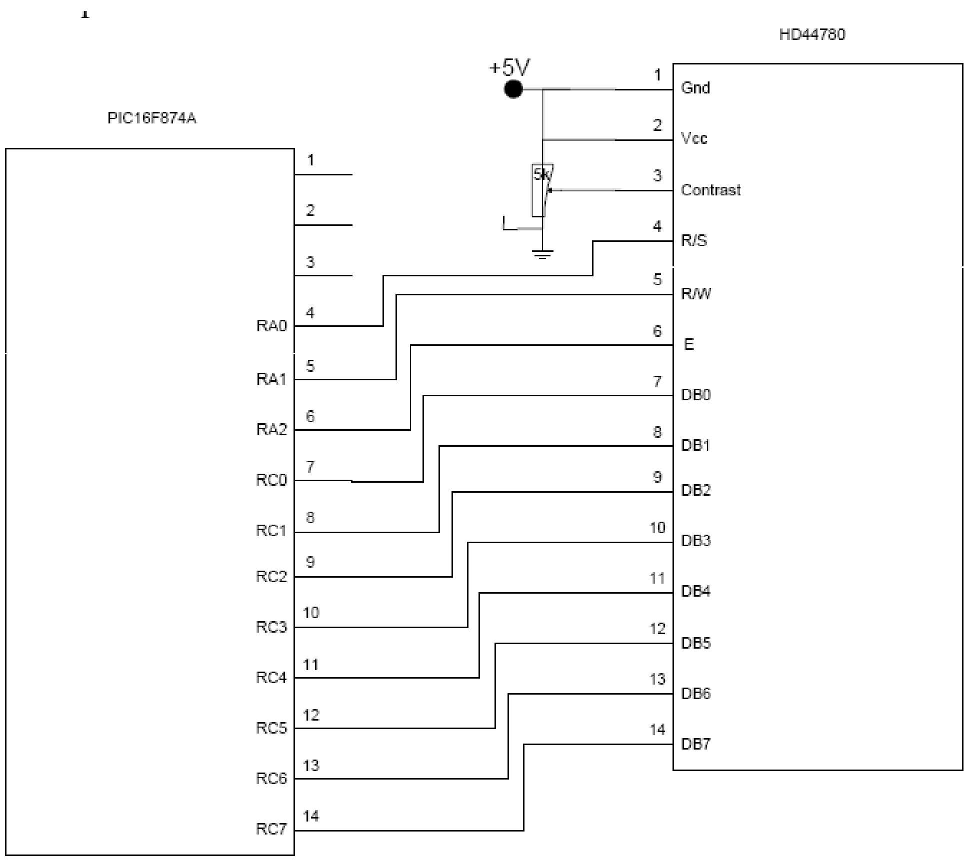
While working with the SP03 speech module it was noticed the built-in microprocessor was running very hot. This was investigated and Matt determined that the microprocessor was drawing about 150 micro-amps while in stand by, and drawing up to about 250 micro-amps while speaking. This was very perplexing since the specifications for the microprocessor said that at most it would draw up to 100 micro-amps. However. there was a second SP03 module in the lab that ran properly and was not doing this. So we will be using this new SP03 speech module since it seems to be working better.

Dave's work for this week began with programming the microprocessor using the Hi-Tech PICC compiler. The beginning of the week was spent working with Hi-Tech technical support to resolve an error with the compiler and MPLab. When he tried to compile a sample program suggested by Hi-Tech as a test, the build failed. He checked the output file of the compiler and discovered an Error [000]: Compiler not installed correctly. After spending a day emailing back and forth with technical support it was determined that the activation code sent to the university was incorrect. The compiler activation program accepted the faulty activation code and failed silently, never alerting the user of the problem. I received a new activation code and the program works successfully.

After getting the Hi-Tech compiler working Dave wrote code to use the analog-to-digital converter using C programming language. The code was modified from an example included with the compiler. Modifications were done to adapt the code for a 20 MHz clock and to configure the pins necessary for our design. He also spent more time this week trying to communicate with the speech module. Dave encountered problems where the command he was sending to the module was getting corrupted in transmission to the speech module. It is believed that the problem is due to a mismatch in baud rate with the RS232 port on the computer. He also wrote some microprocessor code to try to communicate with the speech module.

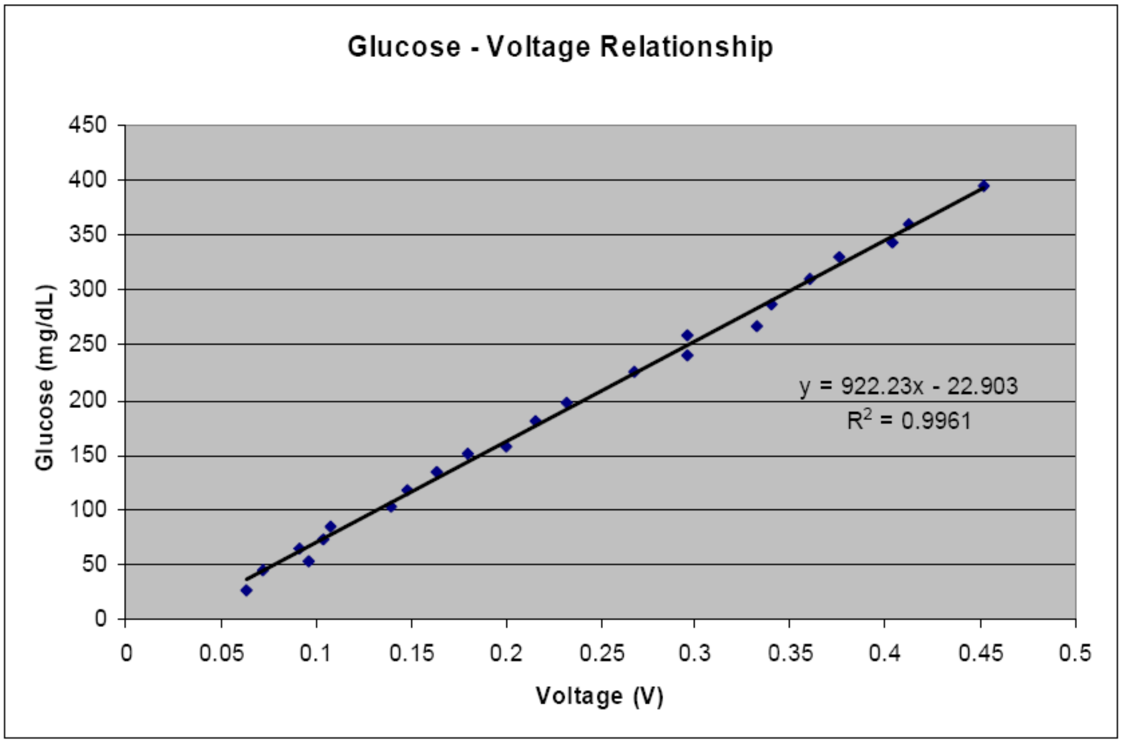
Additional work was done to interface a standard LCD screen with a HD44780 controller. Figure 1 shows the connection diagram for the LCD screen and the microprocessor.

Figure 1: Connection Diagram for LCD Screen to Microprocessor



Mike spent week 6 creating the overall curve for the glucose-voltage relationship. He did this by first diluting the High glucose control solution down to a concentration of about 26 mg/dL. He then gradually increased the level of glucose by adding back drops of the control. Once another drop was added, Mike would then test the sample with the working meter to get the new glucose concentration of the solution. Next, he would run the sample through our glucose circuit, and save the results for that concentration of glucose. In the end, it came to 26 trials and gave a range of data points from 26 to 395 mg/dL. Figure 2 shows the results of the trials after being analyzed in Excel.

Figure 2: Completed Voltage-Glucose Relationship



The equation to the linear trend line is shown as $y = 922.23x - 22.903$, with an R^2 value of .9961. The R^2 value is a measure of how linear the data points are, with a value of 1 being perfectly linear. This means that the data collected is very close to being exactly linear. The equation of the trend line is what will be used by the microprocessor to calculate the glucose concentration. 'X' is the voltage value at 2 seconds after blood application, 'Y' is then the corresponding glucose concentration. Another part of the design that Mike worked on was a circuit that will tell the microprocessor (MP) when to start the 2 second timer to take a measurement. Essentially, once the voltage curve of the blood sample exceeds a certain value, this sub-circuit needs to send 5 volts to the MP, letting it know to start timing. This process is done using a comparator circuit with specific resistors to set a reference voltage. He was not able to get this to work this past week, but it is hopeful that it will be done in the upcoming week.

Future Work

In the upcoming week Matt will continue to work with the speech module if the communication issues can be resolved. He will also pick up where Dave left off on the LCD screen due to the microprocessor is far more complicated than first estimated. Matt will be familiarizing himself with the screen and begin figuring out how to display text. Dave will continue to work on A/D converter and integrating it with the speech circuit and glucose circuit. He will also work on some code to use the SPI or USART port for use with the speech module. Mike will continue to work on the glucose circuit. He will start the circuit on the sample detection for the glucose circuit. This will allow for the meter to determine when blood has been added to the test strip.

Project Review

For speech capability the SP03 module has replaced the Winbond speech chip circuit. This will hopefully prove to be easier and will help facilitate progress in that area. Work will continue to on the speech module as well as with the LCD screen. The microprocessor work is moving slower than expected. Although, this week is looking to be very productive with the microprocessor. Hopefully by the end of the week all three systems will be working with the microprocessor and all the code can be integrated. The glucose circuit is nearing completion which will allow for more work in other areas of the project.