Project Identity
Accessible Blood Glucose Monitor Interface
Week # 3 (January 30 – February 5, 2006)
Mike Rivera

Work Completed

Week 3 made significant progress with the interpretation of the glucose data. An experiment was ran that tested several glucose solutions of different concentrations. This was done first diluting the standard control solution which has a concentration of about 114 mg/dL with deionized water. The stock solution was diluted to about 29 mg/dL to begin with. This solution was then applied to a test strip in the One Touch Ultra Meter to verify what the actual concentration was. Once that was known, the same solution was then applied to the test circuit to record the voltage output that would result. This output was then saved for later analysis. To test a new concentration, 2 drops of the stock solution were added to the diluted beaker, which would then increase the overall concentration of the beaker about 10 mg/dL. This procedure was repeated for 8 trials with the concentrations as follows:

29, 38, 54, 64, 74, 80, 94, and 114 mg/dL.

After completion of the testing, all the saved data on the oscilloscope was then loaded into Excel and analyzed. In Excel, several steps had to be taken to make the data something that could be usable. The first problem was that all the trials had peaks that began at slightly different times within the 25 second window. This was due to when the sample was applied to the test strip as the oscilloscope collected data across the screen. To overcome this, I deleted the beginning portions of each trial to where the data became exclusively positive. This would then begin each data set at the point where the sample is applied and the voltage begins to peak. Following that, the noise of the signal had to be dealt with. The first thought was to apply a trend line to the data to try and obtain a single continuous line that would represent the mass of data points. However, because of the shape of the voltage output signal, there were not many trend lines that could be applied. One trend line that did work was a 'moving average' trend line. This trend line takes continuous averages along the data to form a cleaner representation of the data. Depending on how noisy the data is, one can choose how many points are averaged to a single point on the trend line. Several different values for this were examined, and I decided that 40 per moving average gave a good-looking graph. Figure 1 shows the graph of the trials after being aligned to the same sample time having the trend line applied. With this cleaned up data, the idea now is that at some time after the peak, there is a linear portion with which the measurement can be taken, and accurate results obtained. It seems that about 1 second after the voltage peak (represented by the 4 second line in Figure 1) is a good spot to take measurement. However, this is where the method of the trend line gave rise to a problem. Because it is a trend line, it has no real data points. And because of the nature of the trend line, it cannot be represented through a function. So to obtain data for 1 second after the peak, the raw signal data had to be used. This signal is rather noisy, and therefore has much variation every tenth of a second. I manually searched through the data to attempt to find the times in which the data showed an increasing voltage for increasing glucose concentrations. These were

then plotted and a linear trend line was added to determine exactly how linear the results were. This plot is shown in Figure 2. The R^2 values that are on the side of the plot represent how linear the data is. An R^2 value of 1 means the data is perfectly linear. The best value we received was .9632 which isn't bad, but could use improvement. Overall this tells us that our circuit is promising, and should be able to give an accurate reading once a relationship is made.

Figure 1: Plot of Glucose Data Using 40 Pt. Moving Average

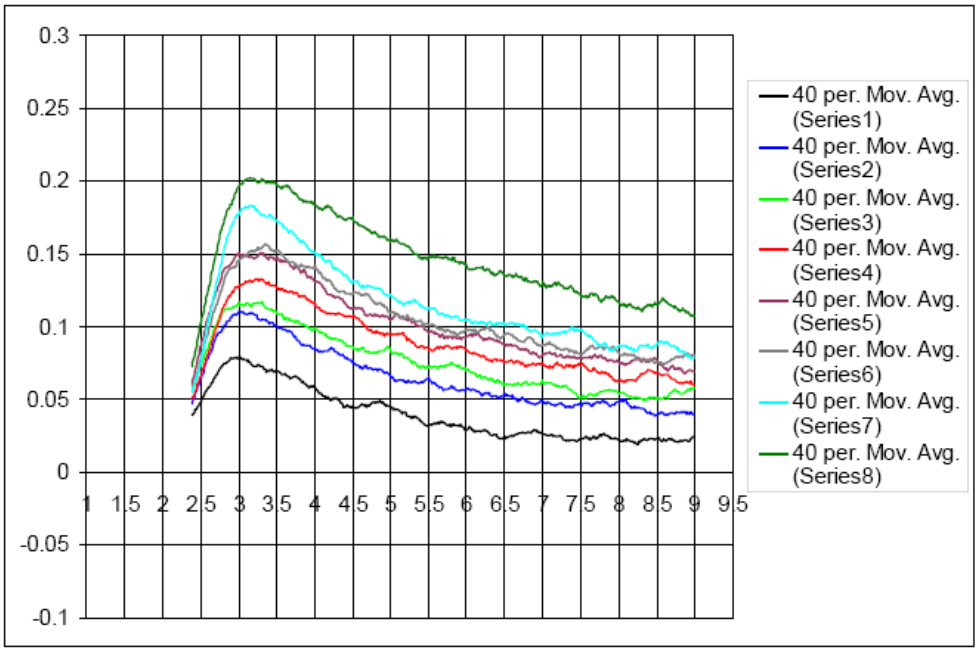
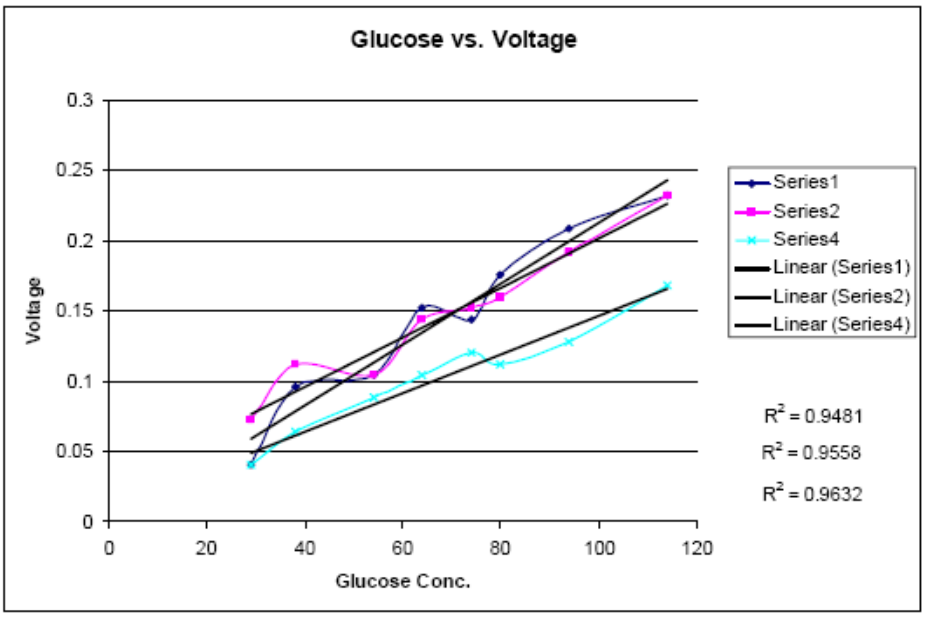


Figure 2: Plot of Glucose versus Voltage for Certain Times Around 1 Second after Sample Application



Future Work

In the upcoming week, more testing needs to be done with the glucose circuit. This same experiment needs to be ran for concentrations above 114 mg/dL. This will be done using a 'high' control solution that we ordered. This solution has a glucose concentration of about 300 mg/dL which would allow for the whole glucose spectrum to be tested. Once the entire range has been tested, the final curve can be examined, and our glucose-voltage relationship can be set.

In addition, Matt has been working on assembling the circuit for the speech chip. Right now, he is waiting on parts to arrive, and will be able to continue with this once they come in. Dave has been working on A/D conversion with the microprocessor, and also has begun to experiment with the LCD screen that recently arrived.

Project Review

So far, so good. No major set-backs occurred this week and significant progress was made in all areas being worked on. It feels as though within the next few weeks, the major components to this project will be on their way to completion. Personally, I am excited to see when we will be able to apply a blood sample to the test strip, and be able to get a reading shown on the LCD. That right there is a glucose meter.

Hours Worked: 14