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Mechanical Engineering

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Using LabView for Signal Processing and Noise Reduction for Flow Cytometry

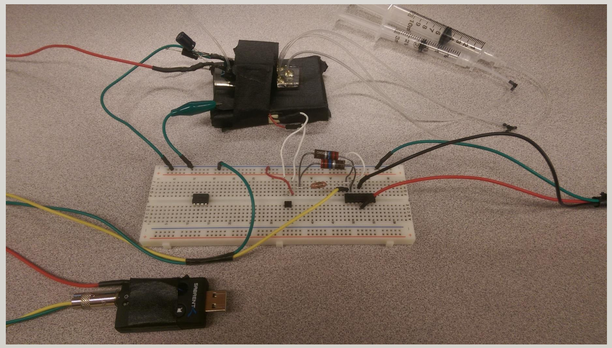
Introduction

Flow cytometry is a process by which microparticles in a fluid can be detected and measured. Most flow cytometers available currently are large and expensive, as they require equipment such as lasers and optics to measure the particles. Our goal was to build a small, lightweight cytometer capable of detecting particles for as little money as possible.

Setup

Our cytometer has three major components:

- Flow module – Particles are passed through a microchannel. An LED above the channel illuminates the particles, and a photodetector below the channel detects them.
- Amplification circuit – The signal from the photodetector is passed through an inverting amplifier to enhance the signal and make particles easier to detect.
- Data acquisition – The amplified signal is connected to a basic USB sound card. The data from the sound card is read by a computer using a LabView program called WaveIO.

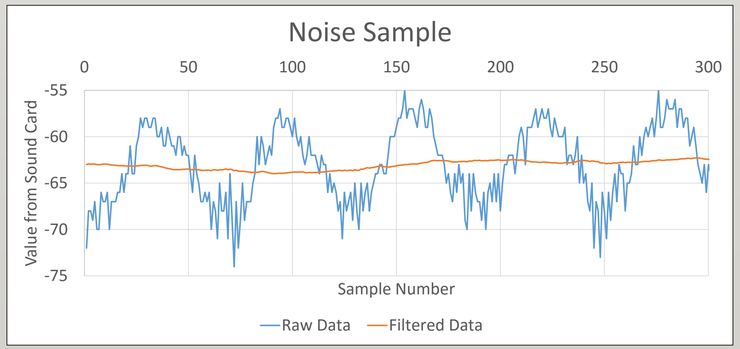


Noise Reduction

One of the greatest problems with our cytometer was electronic noise interference. So much noise was being recorded that signals from the particles were impossible to see. We used LabView to analyze the noise frequency spectrum, and we found two main sources of noise: 60 Hz noise from the AC power supply and 120 Hz noise coming from the lights. We used two methods to try to shield our results from noise:

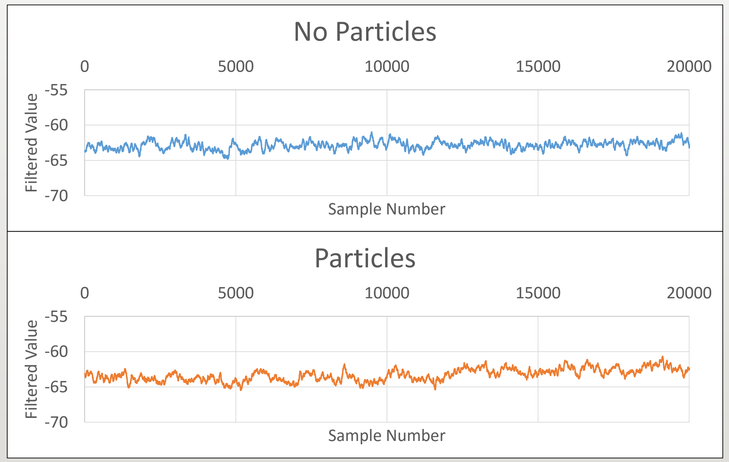
- Physical shielding – We built a large foil box to shield the flow module and amplification circuit from much of the noise.
- Data filtering in LabView – We used an averaging function with a width of exactly one noise period to essentially cancel out most remaining noise. Any deflections from the noise appear as a deviation from the average. We collected data at 3660 samples per second with 61 samples per noise period.

Physical shielding was effective in removing most of the noise. However, when we ran the fluid with particles into the system, it carried some noise in with it. LabView was able to cancel out the remaining noise.



Results

To test the cytometer, we used a sample with a concentration of 50 beads/µL and a flow rate of 20 µL/min. Therefore we expected to see about 17 beads pass through the channel per second. We recorded data both with and without beads to compare the signals. Data collected over about 5 seconds:



Unfortunately, our data still showed no sign of particles passing through the channel. It is possible that they are still hidden by too much noise, but other factors could be the thickness of our microchannel chip and using a sound card for data collection. It may be necessary to convert the DC signal from the sensor to AC before any useful results can be obtained.

References

1. Kettlitz, Valouch, Sittel, Lemmer. “Flexible planar microfluidic chip employing a light emitting diode and a PIN-photodiode for portable flow cytometers”. Lab Chip, 12. pp.197-203.
2. Kalgren, Patrick, and Hashemi, Nastaran. “Portable Flow Cytometry.” Iowa State University Honors Poster Presentation. 2 May 2013.

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