DSP Processing of uFluidics Signal

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Because the uFluidics device generates an extremely weak signal, when the signal reaches the circuit to count the cells, it will have quite a lot of noise in it. In order to accurately count the cells, the signal will need to be processed in order to remove the noise and detect when a cell passes through the device.

I. DSP

The DSP for this project needed to

- Have a low cost
- Have an on board ADC
- Be more than able to process a 5ks/s signal (to allow for changes to processing algorithm)
- Have enough ram to process the above signal in batches of 1024 samples
- Be capable of driving a display or other peripherals to present results

After some searching, a dsPIC33f was determined to be able to fufill the above requirements, and the dsPIC33FJ128GP802 was selected as it had more than enough ram and processing power for our use. Additionally, a less powerful DSP from the same product line could be used in the final product after determining exactly how much ram and processing power are needed

II. Processing

According to [1], the optimal way to separate a known signal from white noise is to use correlation. Via COMSOL simulation and via a crude prototype involving dropping a straw through a coil, the signal of interest would have a shape similar to Figure 1

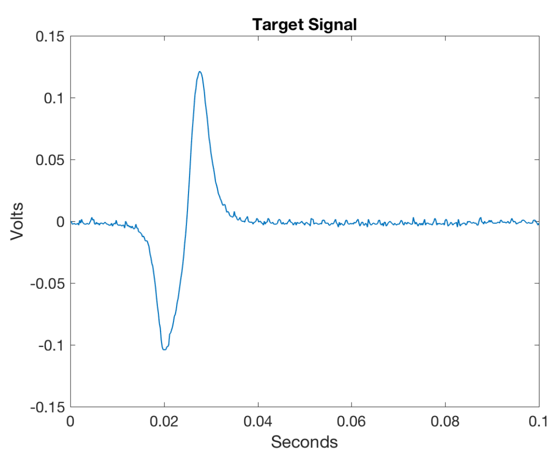

Fig. 1. Signal from prototype device

Therefore we should correlate our input signal with this signal to maximize the separation from noise. To make sure this technique would suit our needs, a script was created in MATLAB to illustrate the effects of the correlation.

First, the signal in Figure 1. was modified by adding some noise, and appears in Figure 2 Next, the signal was correlated

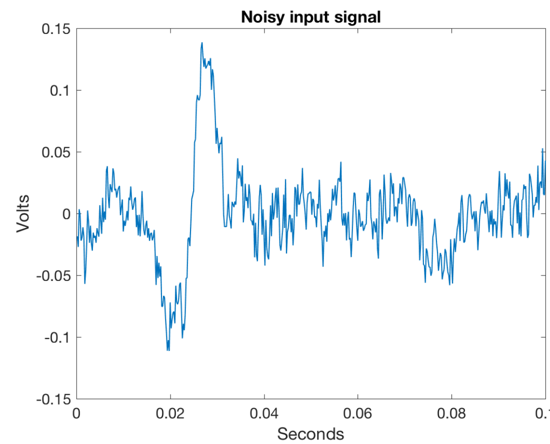

Fig. 2. Signal with simulated noise

with the signal in Figure 3, and the resulting signal appears in Figure 4.

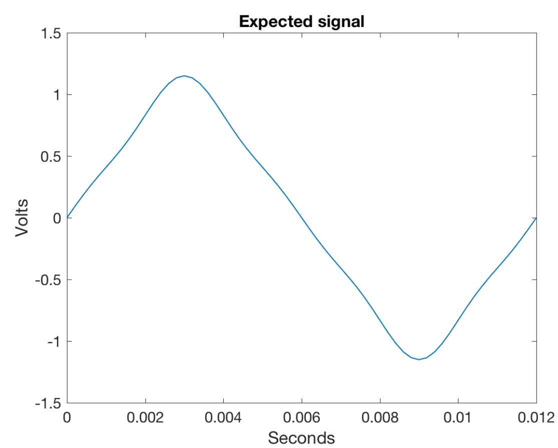

Fig. 3. Correlation target signal

Notice how Figure 4 has several small bumps where the target signal matched weakly with the noise, and also the very large negative spike from where the target signal was lined up with the pulse in the input signal. Unfortunately, the signal from the uFluidics device can be either positive or negative, so further processing is needed. To force both polarities to be positive, the signal in Figure 4 is squared, which also has the effect of reducing the relative amplitude of the spikes from the noise compared with the desired spike. Finally, the number

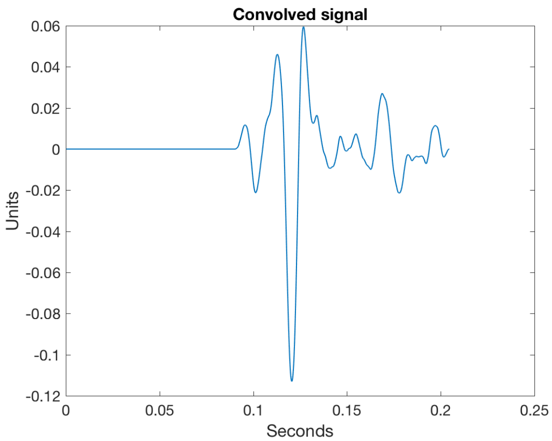

Fig. 4. Result of correlation

of spikes above a threshold value are counted, and the result appears in Figure 5.

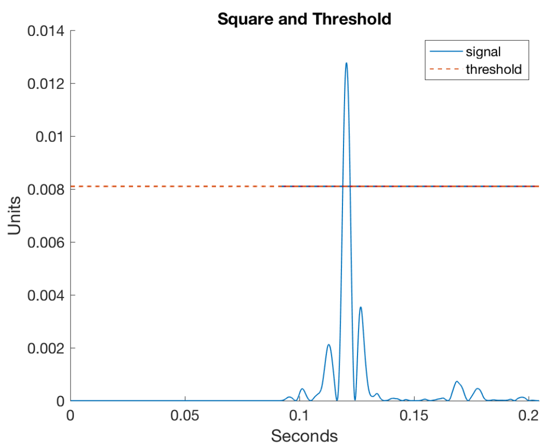

Fig. 5. Squared signal with threshold

REFERENCES

[1] S. Smith, *The Scientist and Engineer's Guide to Digital Signal Processing*. California Technical Pub, 1997.