Nanopore Sensors And Signal Processing

Melvin L Bowers III ,REU
Student, Shepherd University

Uday Shankar Shanthamallu

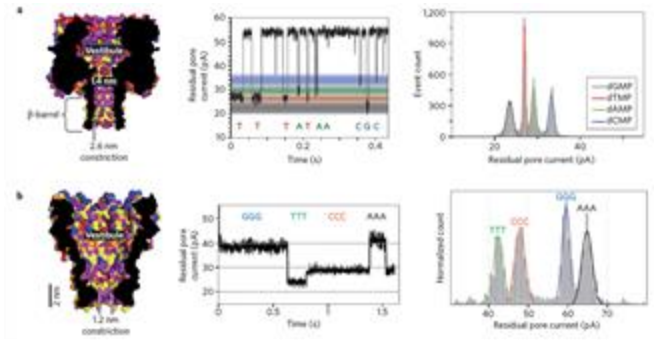
Dr. Michael Goryll and
Dr.Andreas Spanias

***Abstract*—With the help of Ion Channels as well as filtering and, signal processing DNA sequencing can become a more efficient process. To see wavelet filtering would be the best for ion channels we imported ion channel data into Qub. Then used MATLAB to show graphically what the signal looked like. We then utilized MATLAB's toolbox of wavelets to see which wavelet could denoise the noisy ion channel signal, the best. We were able to objectively show the improvement of the signal utilizing specific wavelets to help with the white noise. The maximum observed increase in SNR was 5.42.**

I. (*SUMMARY*)

With the advent of the first computer in the 50's technology and medicine has, slowly moved towards a convergence. Today medical practices and, establishments rely on computers and tablets to store patient information amongst other things for a number of years. Creating a growing need for POC (point of care) devices. If the patient has access to their complete genome, the patient can adapt the prescriptions pharmacogenomically and set up a personalized treatment plan that maximizes the efficiency of the treatment [2]. However, the usefulness of technology has reached an even higher apex with the aid of machine learning algorithms for genetic sequencing. Being able to streamline DNA sequencing is of the upmost importance in today's global society to maintain quality of life as well economic efficiency. Analyzing someone's DNA before cancer can take effect is soon becoming more and more practical as a, method of prevention of this ailment. In addition to the genetic applications comes the benefit of being able to detect toxic molecules [1]. Furthermore, utilizing wavelets as well as the FFT allow for filtering of white noise from the signal. Making for more accurate DNA analysis. The primary method of being able to analyze and sequence involves using nanopores and their ion channels. A nanopore is a tiny hole in a thin membrane filled with water and ions. Usually the nanopore hole is just big enough to allow one ion in at a time. A ion is an atom or molecule with a net electric charge due to the loss or gain of one or more electrons. In order for an ion to make it into the nanopore it must move through an ion channel. This creates an action potential. This movement can be measured by the voltage that is being applied across the nanopore's membrane. In addition to this voltage there is also a current that is being sent through the ion channel itself. Any ion moving through the ion channel will create a disruption in the current which can be measured. The current will change depending on what specifically is passing through the ion channel. Which also will give you a duration of time associated with that specific ion. This would allow the interpreter of this information to be able to deduce what is passing through. Current challenges in utilizing nanopores and ion channel sensing devices are the fact that, the signals are small and signatures are difficult to distinguish from artifacts. It is extremely challenging to detect target biomarkers at concentrations on the order of, typically, ng/ml or less when other abundant nonspecific proteins are present [2].

BIOLOGICAL NANOPORES BEING SEQUENCED. [1]



Sampling and preconcentration and how to get accurate information from the nanopores also poses, a unique issue as well [2]. To attempt to combat some of the issues we wanted to simulate an ion channel signal to determine the expected signal behavior and, analyze specific features in the signal. We felt that utilizing wavelet decomposition to reduce the white noise by picking only the most prominent wavelets would be a good start. We then wanted to determine which wavelets were the most effective at giving the signal a better resolution and, which wavelets weren't as suitable. We also wanted to know how low or high of an order was needed for the most optimal results.

1. J. Clarke, H. Bayley et al., Nature Nanotechnology 4, 265–270 (2009).
2. S. Choi, M. Goryll, L.Y.M. Sin,et al. Microfluid Nanofluid (2011) 10: 231. doi:10.1007/s10404-010-0638-8

3. Amara Gaps an Introduction To wavelets 1070-9924/95/