Announcing the Final Examination of Victor Boyer for the degree of Doctor of Philosophy

Time & Location: October 28, 2015 at 10:00 AM in Engineering Building 2 312L
Title: THE RELATIONSHIP BETWEEN DNA’S PHYSICAL PROPERTIES AND THE DNA MOLECULE’S HARMONIC SIGNATURE, AND RELATED MOTION IN WATER--A COMPUTATIONAL INVESTIGATION

This research investigates through computational methods whether the physical properties of DNA contribute to its harmonic signature, the uniqueness of that signature if present, and motion of the DNA molecule in water. When DNA is solvated in water at normal ‘room temperature’, it experiences a vibration due to the Brownian motion of the particles in the water colliding with the DNA. The null hypothesis is that there is no evidence to suggest a relationship between DNA’s motion and strand length, while the alternative hypothesis is that there is evidence to suggest a relationship between DNA’s vibrational motion and strand length. In a similar vein to the first hypothesis, a second hypothesis posits that DNA’s vibrational motion may be dependent on strand content. The nature of this relationship is not hypothesized by this research but will be discovered by testing if there is evidence to suggest a relationship between DNA’s motion and strand length. The research also aims to discover whether the motion of DNA, when it varies by strand length and/or content, is sufficiently unique to allow that DNA to be identified in a manner similar to a signature. Finally, the question of whether it might be possible to identify a strand of unique DNA by base pair configuration solely from its vibrational signature, or if not, whether it might be possible to identify changes existing inside of a known DNA strand (such as corruption) is explored.

Using Fourier transforms of pressure readings, the simulation investigation could not reject the null hypotheses that the frequencies observed in the system runs are independent of the DNA strand length or content being studied. To be clear, frequency variations were present in the in silico replications of the DNA in ionized solutions, but we were unable to conclude that those variations were not due to other system factors. Chief among the factors is the possibility that the water box itself is the source of a large amount of vibrational noise that makes it difficult or impossible with the tools that we had at our disposal to isolate any signals emitted by the DNA strands. Assuming the water-box itself was a source of large amounts of vibrational noise, an emergent hypothesis was generated and additional post-hoc testing was undertaken to attempt to isolate and then filter the water box noise from the rest of the system frequencies. With conclusive results we found that the water box is responsible for the majority of the signals being recorded, resulting in very low signal amplitudes from the DNA molecules themselves. Using these low signal amplitudes being emitted by the DNA, we could not be conclusively uniquely associate either DNA length or content with the remaining observed frequencies. A brief look at a future possible isolation technique, wavelet analysis, was conducted. Finally, because these results are dependent on the tools at our disposal and hence by no means conclusive, suggestions for future research to expand on and further test these hypotheses are made.

Major: Industrial Engineering

Educational Career:
Bachelor’s of Electrical Engineering Technology, BS, 2007, University of Central Florida
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Committee in Charge:
Michael Proctor, Chair, Industrial Engineering and Management Systems
Richard Calloway, Seminole State College
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Approved for distribution by Michael Proctor, Committee Chair, on November 13, 2015.

The public is welcome to attend.