Undergraduate Research Symposium May 19, 2017 Mary Gates Hall

Online Proceedings

Poster Session 1

Commons East, Easel 59

11:00 AM to 1:00 PM

Phase Detection of Clock Recoverable Serial Data Signals

Yangming Ke, Senior, Applied & Computational Mathematical Sciences (Discrete Mathematics & Algorithms), Electrical Engineering
Mentor: Scott Hauck, Electrical Engineering
Mentor: Logan Adams

The Large Hadron Collider (LHC) is the world's largest particle physics experiment. Physicists are most interested in observing rare events. Because the events are so rare, the speed at which data can be acquired defines the effectiveness of the science. There is ongoing development to improve the data acquisition capability of the LHC. A large upgrade of the detector is scheduled in the next few years, known as the High Luminosity LHC upgrade. Many of the chips that will be implemented during this upgrade are not finished with development yet. A specific chip, the RD-53A, is integral to the system, and will not be available for some time. In the meantime, an emulator for the chip which has the same function as the chip and can be used in LHC is being developed at the University of Washington. One important feature of the emulator is recovering data from high-speed asynchronous data. Recovered data could contain glitches or be invalid if it is not aligned with the local clock. This project defines the way by which the recovered data will be stabilized. By oversampling input serial data signals and examining the pattern of serial data, the phase of recovered data can be determined. After determining the phase of the data, the data can be safely used. Detecting the correct phase of the data is crucial for the LHC because it needs to accurately decode every bit of data collected from physical events.

Poster Session 2

Commons West, Easel 27

1:00 PM to 2:30 PM

Environmental Screening of Poliovirus Using Recombinase Polymerase Amplification

Daysha Gunther, Senior, Public Health-Global Health
Mentor: John Scott Meschke, Environmental & Occupational Health Sciences
Mentor: Nicola Beck, DEOHS

Polio is on the cusp of worldwide eradication but remains endemic in Afghanistan and Pakistan. Nigeria's endemic status is being reconsidered because poliovirus was found in circulation after two years being polio-free. The Global Polio Eradication Initiative has implemented an environmental surveillance program to detect poliovirus (PV) in environmental samples such as sewage. Systematic environmental sampling provides supplemental data to disease-based clinical surveillance data. However, traditional PV detection methods from environmental samples, cell culture and quantitative reverse transcriptase polymerase chain reaction (RT-qPCR), are time consuming and expensive. Development of a screening test has potential to streamline environmental surveillance of PV. Reverse transcriptase recombinase polymerase amplification (RT-RPA) is an isothermal molecular amplification technique with potential as a screening test. In this technique virus particles are lysed to release RNA, which is converted to cDNA and amplified using recombinase enzymes. Amplified PV cDNA can then be detected through lateral flow detection. Collaborators at PATH have developed a RT-RPA protocol that has shown promise in rapid PV detection in stool samples. The aim of this research is to adapt PATH's clinical PV RT-RPA protocol for use with environmental concentrates and to determine the limit of detection. Concentrates will be obtained by filtering raw sewage from a Seattle wastewater treatment plant. Results of the RT-RPA test and subsequent visualization on lateral flow detection strip will be compared to cell culture and RT-qPCR. We anticipate that RT-RPA will show a similar limit of detection when compared to traditional methods and will be suitable as a rapid screening test for environmental concentrates. Future work will include determining the specificity of RT-RPA. Rapid PV detection with RT-RPA may streamline environmental surveillance methods, improve outbreak detection, and provide data for certification of polio-free status and global eradication.

POSTER SESSION 2

Commons West, Easel 28

1:00 PM to 2:30 PM

A Review of Transmission Pathways of Cholera with a Focus on Pregnant Women

Sophie Claire Morse, Junior, Microbiology
Mentor: John Scott Meschke, Environmental & Occupational Health Sciences

In the past few years, cholera has caused many outbreaks of disease. Many studies have been done on its transmission pathways and its effect on non-pregnant patients. This literature review focused on the application of research to discover the preferred recommendations for pregnant women in an outbreak of cholera. This project explored research in academic journals and other professional publications with keywords such as "cholera and pregnancy" and "cholera transmission." We explored existing transmission pathways of cholera, as well as current recommendations for these specific cases. Such recommendations would be to prevent maternal illness and death, as well as diminishing the risk of fetal demise. It was found that cholera is present in biofilms and endemic in certain regions. Its contamination can be prevented through sewage, chlorination of water, and proper food preparation. This review used the disciplinary lenses of microbiology, clinical medicine, epidemiology, and public health. The information concerning cholera in pregnancy is conflicting regarding fetal demise pertaining to first or third trimester outcomes. However, there is overwhelming evidence pointing to the recommendation to vaccinate in the circumstances of an epidemic. Literature suggests that women who are pregnant are not at a higher risk of getting infected with cholera, however given a change in immune response, the fetus is at a higher mortality risk due to the mother's emesis and dehydration. This review will suggest implementation in regards to vaccination and treatment options.

SESSION 2E

ADVANCED TECHNOLOGIES FOR HEALTHCARE AND OTHER APPLICATIONS

Session Moderator: Daniel Kirschen, Electrical Engineering

MGH 238

3:30 PM to 5:15 PM

* Note: Titles in order of presentation.

FPGA-Accelerated Bloom Filter

Chih Ching (Rick) Lin, Senior, Electrical Engineering
Mentor: Scott Hauck, Electrical Engineering
Mentor: Nathaniel McVicar, Electrical Engineering

Progress in genomics research has led to increasing demands in scientific computing, especially in the field of DNA sequencing. As sequencing technologies have matured over the past decade, the rate of growth in data has outpaced the advancement of sequential processing devices such as CPU-based systems. Field-Programmable Gate Arrays (FPGAs) are reconfigurable computing devices that can be highly customized to suit specific applications, including genomic data processing. In contrast to CPU-based systems, FPGAs are parallel processing devices capable of carrying out computations more efficiently. Additionally, newly emerged memory architectures have greatly improved the random-access performance in genomics applications. One of these is the Hybrid Memory Cube (HMC), whose internal architecture incorporates fast serial communication links and efficient controllers that raise the memory bandwidth limit of the FPGA when compared to traditional DDR DRAM. In our research, we harness the high random-access rate of the HMC and the parallel computing ability of the FPGAs to establish a Bloom filter, an efficient data structure used to confirm membership in a group. The Bloom filter can be utilized to discard erroneous reads generated by normal sequencing techniques and can further relieve the need to account for false information in downstream systems. We constructed a filtering pipeline on the development board that houses a Xilinx Kintex FPGA and the HMC, using only one interface port and 2 GB storage of the HMC. The system is capable of processing 1 billion DNA segments with a maximum length of 64 base pairs. The computing ability of the FPGA along with the high random-access rate of the HMC are highly desirable when processing large amounts of genomic data.

POSTER SESSION 3

Commons West, Easel 42

2:30 PM to 4:00 PM

Return to the Atom: What Role for the U.S. in the New Nuclear Era?

Talia Grace Haller, Senior, Business Administration (Finance), Certificate in International Business, International Studies
Mary Gates Scholar
Julian Christopher Augustus, Senior, International Studies
Madeline Claire (Maddie) Holloway, Senior, International Studies
Brandon James Kavalok, Senior, International Studies
John Salber, Senior, International Studies
Celia Louie, Senior, International Studies, Political Science (Internatl Security)
Mentor: Scott Montgomery, International Studies

This research explores what role the U.S. should adopt in the new nuclear era to ensure that the expansion of nuclear energy capabilities proceeds safely, securely, and without fur-

ther proliferation of weapons. Does the U.S. need to expand its own reactor fleet, using advanced reactor technology, to maintain a position of influence? What policies and measures should it take, if any, with regard to Russia's plan to become a nuclear superpower? Through a broad literature review and interviews with world-renowned experts, this research answers these questions, as well as provides key policy recommendations for the U.S. going forward. Ultimately, our findings make it clear that expanding nuclear energy is critical to meeting U.S. climate objectives, buffering national energy security, and becoming a leader in critical energy technology.

POSTER SESSION 3

Balcony, Easel 120

2:30 PM to 4:00 PM

Elevated Plantar Pressure in Women with History of Metatarsal Stress Fractures

Moritz Lange, Senior, Bioengineering
Mary Gates Scholar, NASA Space Grant Scholar, UW Honors Program
Mentor: Scott Telfer, Orthopaedics and Sports Medicine

Metatarsal stress fractures are among the most common injuries sustained in both recreational and competitive long-distance runners. However, current research lacks a proper understanding of how elevated plantar pressures may pose as a risk indication for stress fractures. Therefore we are proposing a research experiment investigating whether or not elevated plantar pressures exist in women with confirmed stress fractures. We hypothesize that elevated plantar pressures will retrospectively correlate to an increased likelihood of metatarsal stress fracture. In this study, each participant will have a personalized pressure mask of their feet designed that is specifically measured and scaled using their x-ray images. After the successful creation of the personalized mask, all data will be analyzed to investigate absolute, relative and cross-foot ratio comparison between the injured and non-injured contralateral foot. It is anticipated that patients with confirmed metatarsal stress fracture will have relatively larger plantar pressure under the respective fractumetatarsal. The information generated by this experiment may provide valuable insight into understanding metatarsal stress fracture pathogenesis. Further implications could even warrant a secondary study investigating the provision of personalized footwear that lower plantar pressures under the at-risk metatarsal.