Undergraduate Research Symposium May 19, 2017 Mary Gates Hall

Online Proceedings

Poster Session 1

Commons East, Easel 78

11:00 AM to 1:00 PM

Ultrasonic Manipulation of Cell Trajectories in Flow

Dino Axel (Dino) de Raad, Junior, Pre Engineering
CoMotion Mary Gates Innovation Scholar
Mentor: Tom Matula, Applied Physics Laboratory

Manipulation of cell flow is of great interest in flow cytometry (cell sorting and counting), which has numerous diagnostic and laboratory applications. Current techniques use fluorescent markers or impedance in a Coulter Counter to isolate and quantify cells. This experiment takes a novel approach by utilizing ultrasonic waves to redirect cells in flow. Cells and water have similar acoustic impedances (i.e., ultrasonic forces exerted on cells are similar to those exerted on the surrounding fluid). Ultrasound contrast agents, however, have a much different impedance. Both dense and sparse contrast agent (lipid-shelled microbubbles) flow respond to an acoustic field with a significant, directional forcing. Juvenile T-lymphoblast leukemia cells conjugated with the ultrasound contrast agent via streptavadin-biotin-anti-CD7 antibody linkage were redirected via acoustic radiation force in flow. Video data were analyzed using optical flow techniques for the velocity data herein. Since the conjugation process varies widely in the number of markers that attach to cells, the effect of numerous conjugations on the acoustic forcing is unclear. The data provides proof of concept for a robust cell sorting device at significantly lower cost than traditional flow cytometers.

Poster Session 2

Commons East, Easel 48

1:00 PM to 2:30 PM

Effects of Target Surface Tilt on the Planetary Instrument for X-ray Lithochemistry

Elizabeth Marie Farrell, Senior, Astronomy, Physics: Comprehensive Physics
NASA Space Grant Scholar, UW Honors Program
Mentor: W. T. Elam, Applied Physics Laboratory

The Planetary Instrument for X-ray Lithochemistry (PIXL) is a micro-focus x-ray fluorescence spectrometer designed for use by the Mars 2020 rover. X-ray fluorescence is the emission of secondary, or fluorescent, x-rays from a material that has been excited via bombardment of high energy x-ray or gamma radiation. The secondary x-rays emitted by the material have spectral lines characteristic of the elements in the sample. PIXL looks for elemental and spatial signatures of past life. Moreover, its spectroscopic data collection is often affected by target surface tilt. Attenuation of the x-ray beam, i.e. a decrease in beam intensity, increases if the target is tilted away from the detector, and decreases if the target is tilted toward the detector. Attenuation is caused by absorption or deflection of photons from the x-ray beam, and decreases the accuracy of relative chemical abundance measurements. PIXL is programmed to account for these effects, and produce quantitative results identical to those of non-tilted surfaces, however, the accuracy to which it does this is unknown. We tested the model on two standard materials, of known composition, and compared those data to real spectra taken by the instrument at various tilt angles. The results were somewhat inconclusive, as errors were large in elements with relatively low chemical abundance and low signal-to-noise. The code will now need to be refined, and the experiments run again, changing the model until it has reached a desired level of accuracy.

Poster Session 4

Commons West, Easel 9

4:00 PM to 6:00 PM

Doppler Ultrasound Simulator Project

Alyssa L. Schul, Junior, Pre Engineering
Mentor: Daniel Leotta, Applied Physics Laboratory

Duplex ultrasound scanning with both color Doppler and Doppler spectral waveforms is relied upon for diagnosis of vascular disease and selection of patients for further evaluation and treatment. In most duplex ultrasound applications, classification of disease severity is based primarily on alterations in blood flow velocities. Our research group in the Applied Physics Laboratory is collaborating on the development of a Doppler Ultrasound Simulator for training and assessment of scanning skills. The ultrasound simulator allows learners to repeat examinations as many times as necessary to acquire and improve skills. With the addition of clinical cases covering a range of disease severity, this duplex ultrasound simulator will be a useful tool for training

health-care providers in vascular ultrasound applications and for assessing their skills in an objective and quantitative manner. The Doppler Ultrasound Simulator extracts virtual blood flow measurements from computational flow models, with real-time scanning linked to a physical mannequin. The Simulator reproduces the key components of a clinical Doppler ultrasound examination including steering the Doppler beam, selecting the size and location of the Doppler sample volume, specifying the Doppler angle relative to the vessel axis, and adjusting the pulse repetition frequency (scale control) and baseline to avoid aliasing. My research role in this larger-scale project is to use a data processing program, MATLAB, for image reconstruction, processing and analysis. MATALB is used for the creation of 3D image volumes, which are used as the foundation for vessel reconstruction as 3D computer models. MATLAB is also a useful tool for correction of image motion artifacts. My effort in this project involves applying image correcting algorithms to create 3D volumes with enhanced vessel alignment and minimized interference from real-time shifting of 2D ultrasound images.