Online Proceedings

Poster Session 1

MGH 241, Easel 144

12:00 PM to 1:30 PM

Mechanical Effect of Blood Flow on the Carotid Artery Bifurcation

Laura De Barros Van Kolck, Senior, Mechanical Engineering
Mentor: Alberto Aliseda, Mechanical Engineering

The carotid artery bifurcation is one of the main sites of atherosclerosis, a disease that causes plaque buildup on artery walls, which can lead to Stroke. Through examination of the flow in the carotid artery bifurcation, we expect to better understand the influence of hemodynamics on plaque formation and growth, as well as on potential treatments. In order to investigate this, we have designed a model of the carotid artery using medical imaging and computer aided design software (SolidWorks). We are investigating rapid prototyping techniques to create a physical model of the carotid artery. Utilizing the physical model of the carotid artery lumen, we cast a mold made of water soluble material. This allows us to remove the mold leaving behind a reconstruction of the carotid artery with the necessary physical properties. Currently this project is focused on finding an ideal casting process that preserves the optical clarity. The next phase of this research will be to examine flow through the mold using particle image velocimetry (PIV). The setup of the PIV involves adding tracer particles to the flow that are illuminated with a laser. Using the light scattered by the particles to record the displacement collected with a photographic camera synchronized with the laser illumination. These images will be processed using an algorithm that compares the displacement from two consecutive images. The velocity of the flow will be calculated from the displacement of the tracer particles and its profile is used to determine the shear stress acting on the walls of the artery. This measurement of the stress acting on the arterial wall, together with the transport of chemical species to and from the arterial wall, is crucial in understanding the influence of hemodynamics on the physiology of the arterial wall and the development of atherosclerosis.

Poster Session 1

MGH 241, Easel 135

12:00 PM to 1:30 PM

The Helmet Drop Tower Project

Tyler Dennis (Tyler) Wickstrom, Senior, Mechanical Engineering
NASA Space Grant Scholar
Mentor: Irving Scher, Guidance Engineering
Mentor: Randy Ching, Mechanical Engineering, Applied Biomechanics Lab

Helmets have been trusted to provide protection against head impacts for millennia and have become a universally promoted piece of safety equipment. Current helmet standards provided by NOCSAE, SNELL, and ASTM for football, ski, motorcycle, and other activities specify the requirements for critical impacts under varying conditions such as; temperature, impact location, and impact energy. However, most standards only minimally account for the effects of subcritical collisions and the natural fatiguing processes experienced by a helmet during its use. Intuition suggests that these seasonal cycles and minor impacts attenuate the utility of protective headgear; however, a scientific inquiry into such effects could illuminate or invalidate this assumption. The working hypothesis of the research team under Professor Randal Ching and Irv Scher was that sub-critical impacts and seasonal cycling would diminish a helmet's protective abilities (as measured by metrics such as peak linear acceleration and severity indices), and the goal was to illustrate that current standards and refurbishing methods need to account for these various effects of age and use. Accordingly, my research group designed a helmet drop tower to test a variety of different helmets (football, motorcycle, and ski) according to SNELL and NOCSAE standards, and used helmets were compared to their new counterparts. Direct comparisons between used and new helmets were used to evaluate the effects of age and minor impacts on helmets, the effectiveness of current standards at predicting the utility of helmets, and the expected lifetime of helmets under given conditions. As the first independent study of helmet performance in the state of Washington, this study could give vital feedback to helmet manufacturers, helmet standard foundations, and helmet users alike.

Poster Session 2

MGH 241, Easel 156

2:00 PM to 3:30 PM

Centrifugal Method for Particle Size Segregation

Cameron Kelly (Cameron) Turner, Senior, Mechanical Engineering
Christopher Thomas (Chris) Pauly, Senior, Mechanical Engineering, Electrical Engineering, Mathematics
Nicklaus Charles Smith, Senior, Aeronautics & Astronautics
Julianna Carroll, Senior, Aeronautics & Astronautics, English (Creative Writing)
Keith Charles Woehrlin, Senior, Mechanical Engineering: Mechatronics
Joshua Rosenberg Hooks, Senior, Mechanical Engineering: Mechatronics
Ansley Barnard, Senior, Aeronautics & Astronautics
Harbin Hee Kim, Senior, Aeronautics & Astronautics
Declan Pray Mallamo, Senior, Aeronautics & Astronautics
Mary Gates Scholar, NASA Space Grant Scholar
Mentor: James Riley, Mechanical Engineering

Extraterrestrial regolith can be utilized for a variety of in-situ resource utilization applications including the production of oxygen and slurry materials. These capabilities are crucial for the success of long-term missions to both the Moon and Mars. However, the value of the regolith often depends on extracting a specific particle size. Therefore, our objective is to develop a regolith sifting system for integration into extraterrestrial surface systems. Furthermore, this system will be designed to operate independent of gravitational forces in order to offer flexibility by maintaining the same degree of reliability and efficiency in terrestrial, lunar, martian, asteroidal, and orbital environments. To accomplish this task, a centrifuge design was adopted. A container fitted with two sets of sifting screens is rapidly spun so that the centripetal forces cause the particles to pass through the screens. At high speeds the effects of gravity and particle cohesion become negligible. The design was carried through several stages of development where parameters such as geometry, induced agitation, sample size, rotation speed, and test duration were optimized to give accurate sorting results with minimal energy input. Data collected from ground testing will be compared to data collected on NASA's low-gravity aircraft in June. The low-gravity testing introduces more challenges to the design, such as automated gates that keep the particles from self-sorting in between low-gravity flight parabolas, and integration into a air-tight glove-box for safety. For future research, techniques for autonomous and continuous operation will be crucial for adoption into extraterrestrial surface systems.

POSTER SESSION 2

MGH 241, Easel 170

2:00 PM to 3:30 PM

Fluorescent Detection and Photodynamic Therapy of Cancer Using 5-ala Induced PpIX and a Scanning Fiber Endoscope

Mikias Habteab (Mikias) Woldetensae, Freshman, Pre Engineering
Mentor: Mark Kirshenbaum, Mechanical Engineering
Mentor: Eric Seibel, Mechanical Engineering

The National Cancer Institute estimates that there will be 73,510 new cases of bladder cancer in the United States during the year 2012, and an expected 14,880 deaths due to the disease. With a 50-70% chance of recurrence, bladder cancer is one of the most expensive cancers to treat. If detected and treated early, the cost of this cancer could be dramatically reduced. Some current methods of detection are conducted by using a cystoscope inserted through the urethra to image the interior wall of the bladder. These cystoscopes can be fairly large—ranging from 3.3-5.3mm in diameter—and sometimes require general anesthetics, which increase costs due to additional bodies within the operating room. In contrast, the scanning fiber endoscope (SFE) developed in our lab is 1.2-1.6mm in diameter; at this small size the cost of anesthetics can be greatly reduced. In addition the SFE produces high resolution images by using red, green, and blue diode laser light from a single scanning optical fiber. Our research aims to combine the cancer specific biomarker 5-Aminolevulinic acid (5-ALA) and the SFE to fluorescently detect and treat cancerous legions. Once inside a cell 5-ALA converts to Protoporphyrin IX (PPIX), which has a fluorescent excitation peak at 405nm; the corresponding emission peak at 635nm causes cancerous regions to appear red. This is possible because 5-ALA has a high binding affinity to cancerous cells, allowing for a contrast to be seen between healthy and abnormal cells during fluorescent imaging. With prolonged 405nm light exposure and an increase in laser power, we can also cause death of cancerous cells with photodynamic therapy (PDT). PDT causes the photosensitive and cancer bound PpIX to release a singlet oxygen molecule, which in turn destroys vital organelles within the cancer cells, leading to the eventual death of the cancerous mass.

SESSION 2L

MCNAIR SESSION - ACCESS AND TECHNOLOGY

Session Moderator: Eve Riskin, Electrical Engineering

Mary Gates Hall 287

3:30 PM to 5:00 PM

* Note: Titles in order of presentation.

The Relationship of Young's Modulus to Porosity in 3DP Stoneware Ceramic: A Complete Analysis

Alexandra Patricia Kanoelehua (Alex) Gramling, Senior, Mechanical Engineering
McNair Scholar
Mentor: Mark Ganter, Mechanical Engineering
Mentor: Grant Marchelli, Mechanical Engineering

Three dimensional printing (3DP), a subfield of additive manufacturing, has experienced many novel advancements by way of innovative material development over the past few years. With the recent expansion in capability, information regarding the mechanical integrity of these new material systems is generally lacking. In an effort to fill this informational void, the present study examined the relationship between Young's modulus and porosity in 3DP stoneware ceramic test specimens. During this experiment, the ceramic specimens or "pucks" were printed using a three dimensional powder printer and measurements of height and diameter were taken to map the variation in subsequent kiln firing operations. The pucks were kiln sintered according to a predetermined schedule, which involved strategically placed ramp rates and isothermal soaks for varying time periods. After sintering, Archimedes Method was used to determine the porosity and bulk density of the specimens. The pucks were then crushed using an Instron Universal Tester resulting in a measure of the 3DP stoneware's stiffness versus porosity. It is expected that as the porosity of the pucks increases Young's modulus will decrease. The aim of this research is to provide the first experimental relationships of porosity and stiffness resulting from sintering parameter modification as well as to investigate the possibility of producing 3DP ceramics that are comparable to those that are conventionally manufactured.

POSTER SESSION 3

Commons East, Easel 74

4:00 PM to 5:30 PM

Comparison and Implementation of Multi-Legged Gait Patterns

Kurt Joseph (Kurt) Stalsberg, Junior, Mechanical Engineering
Mentor: Scott Wilcox, Mechanical Engineering
Mentor: Santosh Devasia, Mechanical Engineering

Multi-Legged terrestrial biological systems demonstrate complex forms of locomotion by utilizing different gait patterns. These complex forms of locomotion provide a path for promising advancements in the development of biomimetic systems. In previous research, we analyzed various multi-legged terrestrial systems and several variables that effect the selection of the gait pattern became apparent. It was found that the number of legs, stability of the system, and velocity of the system all had a significant effect on the gait patterns selected and the gait patterns that are available for use in the system. This research focuses on constructing biomimetic walking systems, using LEGO Mindstorms NXT robotic kit, which implement the carious characteristics of animal locomotion to determine the effect of these variables on the gait patterns. The current systems under analysis consist of six legs controlled by interactive servo motors and an NXT micro-computer which allow the system to move with several distinct gait patterns. From the biomimetic system, it is shown that some gait patterns are inefficient under certain conditions and this may lead to determination of when a gait pattern change is necessary in both the biological and biomimetic systems. Application of this research include pattern selection in mechanical systems and design influence on biomimetic systmes.