Undergraduate Research Symposium May 17, 2013 Mary Gates Hall

Online Proceedings

POSTER SESSION 1

Commons East, Easel 44

11:00 AM to 12:30 PM

Quadrotor Flight with On-Board Autonomous Controlling

Francesca Theresa (Francesca) Liburdy, Junior, Extended Pre-Engineering

NASA Space Grant Scholar

Mentor: Kristi Morgansen, Aeronautics & Astronautics

Mentor: Brian Hinson, Aeronautics & Astronautics

A quadrotor is a small air vehicle propelled by four rotors, or propellers. It is capable of vertical flight, as well as hovering and smoothly changing direction. The quadrotor is more versatile than a fixed-wing air vehicle, as it can move through environments that would limit a larger and less maneuverable vehicle. This research aims to create a successful autonomous computer-based controlling system for a quadrotor's flight. By implementing this technology, the quadrotor could move freely in environments unsafe for human flight controllers. Researchers developed and executed experiments to determine vehicle properties to improve control safety and robustness. In order to create a flight control system that will successfully maneuver the quadrotor without the use of a remote control, the quadrotor's inertia and thrust properties were ascertained. With the inertia and thrust data, controlling the quadrotor with high precision will be possible. The quadrotor's inertia was determined by measuring its rotational period using a photogate timing mechanism and a flashlight beam. Its inertia was found on three principal axes: x, y, and z. A thrust curve was determined for the quadrotor by measuring the thrust produced at each throttle setting using a force transducer. The resulting inertia and thrust properties allow for a deeper analysis of the quadrotor's abilities. In addition, an optic flow sensor will contribute to the quadrotor's flight capabilities. The sensor was calibrated and code was implemented to create communication between the sensor and a computer. When attached to the quadrotor, the sensor rapidly photographs the quadrotor's surroundings, detecting changes in altitude, rotation, and velocity. The optic flow sensor will help stabilize the quadrotor's position and allow it to maneuver away from objects in its flight path.

POSTER SESSION 1

Commons East, Easel 63

11:00 AM to 12:30 PM

Molecular Mechanisms of Differential Response to Environmental Mitochondrial Toxins

Xiaoli Wu, Freshman, Exchange - Arts & Sciences

Mentor: Matt Kaeberlein, Pathology

Mentor: Brian Wasko, Department of Pathology

Humans are exposed to environmental toxins which can contribute to acute or chronic diseases, such as Parkinson's disease. Different people, however, have variable susceptibility to these toxins due to genetic variability within the population. In this project, we will utilize the model organism Saccharomyces cerevisiae(yeast) to investigate the molecular mechanisms of differential responses to environmental toxins that target the mitochondria. Many yeast single-gene deletion mutants will be exposed to mitochondrial toxins using a high-throughput Biosreen C instrument(combined shaker, incubator and plate reader, allowing for growth rate determination of yeast cells) and subsequently, bioinformatic methods will be exploited to identify genes involved in the response to mitochondrial stress and mechanisms of toxicity. We explored optimum concentration of different toxins for mutant yeast, expecting that different mutations will response genotype-dependently to different compounds. Identifying genotype-dependent responses to the environmental mitochondrial toxins may illuminate how mitochondria toxins contribute to disease and identify genetic factors invovled in susceptibility.

POSTER SESSION 2

MGH 241, Easel 132

12:45 PM to 2:15 PM

Optimizing the T-Section of Structural Parts Constructed Using Cellular Core Technology

Kevin Braun, Senior, Mat Sci & Engr: Nanosci & Moleculr Engr

Mentor: Brian Flinn, Materials Science & Engineering

The aerospace industry today utilizes composite materials for a number of structural components due to their high strength to weight properties. Assembling these composite parts to an airplane currently requires fasteners such as bolts or riv-

ets, even though they add weight and reduce the mechanical properties of the composite parts. Integrated monolithic composite structures not requiring bonding or fastening could improve the strength, fuel efficiency, and ease of assembly of a commercial airplane. Cellular Core Technology (CCT) has been used to create double-box beam composite structures that do not require traditional fastening. The cellular cores provide an internal surface which can apply heat and pressure to all surfaces of a part allowing for high consolidation of complex structures. The consolidation at joints within integrated structures has been a prospective problem, leading to high void content and stress concentrations causing premature failure. The effect of fiber orientation on the expansion of the cellular cores was studied to determine if the fibers restrict the pressure provided by expansion. Double box beams were fabricated while altering the fiber orientation of the carbon fiber plies between 0/90 degrees and +/-45 degrees. After curing, the expansion of the cellular cores for each structure was investigated in order to determine the effect of fiber direction on the restriction of cellular cores and subsequent porosity in the joints. Optical microscopy was used to assess porosity around the joints of each double box beam. Mechanical tests were performed using Digital Image Correlation (DIC) to evaluate the effect of fiber orientation on the stress and strain fields throughout the T-joint geometry. Future work will include determining additional factors that affect the porosity of the joints such as the relationship between the number of plies and the expansion capabilities and the expansion limits for the cellular cores.

POSTER SESSION 2

MGH 241, Easel 133

12:45 PM to 2:15 PM

Influence of Matrix Resin Mechanical Properties on Mechanochromic Fluorescent Damage Probe Response

Natalie Marie (Natalie) Larson, Senior, Mat Sci & Engr: Nanosci & Moleculr Engr

NASA Space Grant Scholar, Washington Research Foundation Fellow

Mentor: Brian Flinn, Materials Science & Engineering

A non-destructive inspection (NDI) technique that integrates mechanochromic fluorescent probe molecules into aerospace composite matrix resins was investigated. The NDI technique aims to allow quick and inexpensive inspection of aerospace composites that could reduce the need to overdesign composite structures for undetected damage. This experiment was focused on determining the effect of the matrix resin mechanical properties on the activity of the fluorescent probe molecule. In the first step of this experiment, samples of epoxy (diglycidyl ether of bisphenol A (DGEBA)-diethylenetriamine (DETA)) functionalized with fluorescent probe molecules were fabricated. To change the mechanical properties of the epoxy samples, diglycidyl ether (polypropylene glycol) (DGE(PPG)) was added to the samples incrementally from 0-100 weight percent (wt%). To determine the effect of mechanical deformation on the probe in cured DGEBA/DGE(PPG)-DETA, fluorescence spectra were taken before and after incremental compression of the functionalized epoxy samples. The fluorescence testing revealed that the fluorescence activation increases with increasing compressive strain, strain energy, and stress, with a linear relation between fluorescence activation and strain. Furthermore, the fluorescence testing revealed that the fluorescence activation decreased as the modulus of the sample decreased, with the exception of the neat DGEBA-DETA sample. The fluorescence testing also revealed that, without exception, the fluorescence activation decreased as the glass transition temperature decreased and as the wt% DGE(PPG) increased, with no fluorescence activation for 40 wt% DGE(PPG) and above. These results suggest that the sample's composition (wt% DGE(PPG)) and thermal properties (Tg) are more dominant factors affecting the probe's response than the sample's mechanical properties. Future work on this research will be aimed at determining why, on a molecular scale, the probe response decreases with increasing wt% DGE(PPG) and decreasing Tg.

POSTER SESSION 2

MGH 241, Easel 134

12:45 PM to 2:15 PM

Effect of Nanoscale Elements on the Mechanical Performance of a Composite Cooling Pump Cover

Robert Thomas (Robert) Morris, Senior, Mat Sci & Engr: Nanosci & Moleculr Engr

Mentor: Brian Flinn, Materials Science & Engineering

My senior research project consisted of the manufacturing and development of a composite structure for the encasement of the cooling pump for UW Eco Car II. The purpose of creating this structure was to discover the relationship between nanoscale elements (voids, impurities, toughening particles) and the mechanical performance of the composite while maintaining an acceptable strength-to-weight ratio. The composite box was constructed using S-glass fiber plies and a two-part epoxy resin matrix. The wetting of the plies was done using a hand lay up technique. Once each ply was fully impregnated with the resin matrix, the plies were then transferred onto a wood tool that was covered in fluorinated ethylene propylene (FEP). Subsequent wrapping of perforated FEP, bleeder material, and another layer of FEP was bagged under vacuum and left to cure at room temperature. Although this object was cured at room temperature, the use of an autoclave could enhance the mechanical stability of the composite. The combination of heat and pressure would eliminate nanoscale impurities such as voids or

semi-crystalline regions as well as promote adhesion of the matrix and fibers. Moreover, the addition of thermoplastic nanoparticles such as polyester could effectively reduce interlaminar shear. Further analysis was conducted into finding the optimal size of these particles to maximize the performance of the composite structure. Through controlled techniques and a proper cure time, a uniform composite casing was fabricated and mounted in the trunk of the Eco Car II. The introduction of thermoplastic elastomeric nanoparticles into the epoxy resin matrix during the mixing process could effectively toughen the composite and would require an autoclave autoclave to ensure the particles were co-continuous within the matrix. At this stage, the thermoset keeps its high glass transition temperature while the thermoplastic increases toughness.

POSTER SESSION 2

Balcony, Easel 115

12:45 PM to 2:15 PM

Investigation into Growth and Lipid Production of Two *Botryococcus Braunii* Strains as Potential Biofuel Feedstock

Alexander (Alex) West, Sophomore, Biology, Computer Science, North Seattle College
Debra Del Castillo, Fifth Year, Biochemistry, North Seattle College
Joanna Qiao Zuo Liew, Senior,
Zeno DeRooy, Sophomore, Chemistry, North Seattle College
Richard Won (Richard) Lee, Junior, Extended Pre-Major
Jennifer Elliott

Mentor: James Patterson, Chemistry, North Seattle Community College
Mentor: Brian Saunders, Biology, North Seattle Community College

Two strains of *Botryococcus braunii* algae were grown in three different sets of conditions to compare growth characteristics and lipid production. One species, UTEX LB 572, was a Race A *Botryococcus braunii* from the culture collection of the University of Texas in Austin. The second species, AC 762, was a Race B *Botryococcus braunii* from the culture collection of the University of Caen, France. UTEX 572 was found to produce two hydrocarbon chain lengths of C:16 and C:18 in a 2:3 ratio respectively. The AC 762 was found to produce hydrocarbons called botryococcenes of chain lengths between C:30 and C:36. The lipid chain lengths of both strains were evaluated by mass spectrometry. The UTEX 572 lipid content was quantified by analytical spectrometry after direct transesterification of the lipid content to biodiesel. The AC 762 lipid content was quantified by a photospectrometry technique developed by UC Berkeley researchers Eroglu and Melis (1985). Cells of both species were harvested during exponential growth phase from 400 mL of growth media and then freeze dried and analyzed gravimetrically. Nine flasks of each species were grown with 3000 lux average light intensity on a 12h:12h light:dark cycle at room temperature averaging 22 C. Three flasks of each species were grown with 1.5% CO2 in BG-11 media, three flasks of each species were grown in BG-11 media with air only and three control flasks were grown in respective carrier medias as those used in the algae collection of origin. Knowledge of the rates at which AC 762 and UTEX 572 produce hydrocarbons as well as the specific lengths and proportions of those hydrocarbons contributes to data needed for comparison of economic considerations in industrial applications.

POSTER SESSION 3

MGH 241, Easel 160

2:30 PM to 4:00 PM

Influencing Colorectal Cancer Screening through Health Education

Avigail Galvan, Senior, Biology, Heritage College
McNair Scholar
Mentor: Katherine Briant, Fred Hutchinson Cancer Research Center
Mentor: Beti Thompson, Cancer Prevention Program, Fred Hutchinson Cancer Research Center
Mentor: Genoveva Ibarra, Fred Hutchinson Cancer Research Center

Colorectal cancer is the third most common cancer in the United States; and is also the third for highest mortality rate. About 90% of all Colorectal Cancer (CRC) cases are in people 50 years of age or older. For that reason, colorectal cancer screening tests such as the FOBT and colonoscopy are recommended for everyone over 50. Colorectal Cancer death rates in Washington State go up by age but differ by ethnicity. They are highest in African Americans (27.5 per 100,000), Native Americans (14.8 per 100,000), Whites (14.8 per 100,000), and Hispanics (13.4 per 100,000). CRC has a high chance of being treated successfully if caught at an early stage, with up to 90% of early cancers being successfully treated and/or prevented. In this study, we will ascertain if Hispanics and Native Americans are more likely to complete a colorectal cancer screening test after getting a tour of the large inflatable colon (CASPER). The colossal colon is a walk-through inflatable replica of the human colon. It illustrates examples of healthy colon tissue, as well as polyps and colon cancer. The study uses a pre/post-test design. Each participant will be asked to complete a brief test. Pre-test questions ask basic questions to assess knowledge about colorectal cancer and attitudes about colorectal cancer screening. A pre-test is completed before walking through CASPER. Post-test questions will ask the same basic colorectal cancer knowledge and attitude questions to see if there is a change after walking through

the inflatable colon. Data analysis was done using paired t-tests to assess changes, if any, using Excel. The results show significant changes in participant likelihood to have a CRC screening, CRC knowledge, perceived knowledge, and likelihood to talk to acquaintances about CRC screening. They also show that CASPER is an effective way to educate participant about CRC.

POSTER SESSION 3

Balcony, Easel 109

2:30 PM to 4:00 PM

An Exploration of Binary Stars

Adrian Luis (Adrian) Davila, Freshman, Astronomy, Physics: Comprehensive Physics
Cameron Mitchell Harmon, Freshman, Pre-Sciences
Mentor: Eric Agol, Astronomy
Mentor: Brian Lee, Astronomy

Binary star systems offer a deeper insight in regards to the properties of the stars in those systems, as opposed to the observation of a single star. Information from binary stars can help to better understand the lifecycle of stars, the interation among stars, and more accurate predictions as to the mass and radius of certain stars. This study analyzed the radial velocity and lightcurve data from eight binary star systems. Data were collected from the Kepler Space Telescope MAST database. A variety of IDL routines were used in analyzing the lightcurve data. When looking at the lightcurve data we were able to make a breakdown of the curves, determining what portions of light were contributed by Doppler beaming, ellipsoidal deformation and reflection off of the stars. These IDL routines are essentially bits of code used to analyze the data in a systematic manner. We were also able to make rough estimates of the masses and radii of some of the stars using simplified versions of Doppler beaming equations. From the results we were able to identify heartbeat star systems, eclipsing and non-eclipsing binary star systems as well as the periods of the orbits of these systems. Starspots proved to make the interpretation of lightcurves more difficult as they introduced inconsistent changes into the lightcurve data by showing a decrease in magnitude as if from an ecclipsing object but instead from the starspot itself. Future work includes resolving more accurate radii and masses by taking into account the inclination of the orbits by looking more in depth at the radial velocities.

POSTER SESSION 3

MGH 241, Easel 157

2:30 PM to 4:00 PM

Genetic Comparison of Heat-Shock Proteins in Two Intertidal Sea Anemones as Models for Climate Change in Puget Sound

Jennifer Mai, Non-Matriculated, Neuroscience, Physiology , North Seattle College
Mentor: Brian Saunders, Biology, North Seattle Community College

Select proteins from the HSP70 gene family were studied in *Anthopleura artemisia* and *Anthopleura elegantissima*, two intertidal sea anemones found in Puget Sound. *A. elegantissima* are clonal aggregates that are found on rocks while *A. artemisia* live buried, solo within sand. HSP70 are a family of heat shock proteins that are present in prokaryotes and eukaryotes that regulate various protein functions such as heat stress or protein folding. PCR techniques were utilized to determine the presence of HSP70 genes. It is predicted that both species have similar or identical genes that produce HSP70 heat shock proteins, but differ in how the HSP70 genes are expressed. In prior studies, *A. elegantissima* are found to express HSP70 proteins depending on position in a colony (edge versus central positions). *A. artemisia*, allows for an interesting comparison as to how living conditions would affect the expressions of HSP70 proteins. RT-PCR techniques were utilized to determine HSP70 gene expression in both species. Variations of HSP70 expression can be used to generate models to predict the effect of climate change in the Puget Sound area.

POSTER SESSION 4

Commons West, Easel 22

4:15 PM to 5:45 PM

Approaches to Identifying Tobacco Use Patterns

Dale Sim (Dale) Kim, Senior, Psychology
Mentor: Brian Flaherty, Psychology

Different groups of smokers are commonly discussed in the research literature on tobacco use and nicotine dependence. Examples include heavy smokers, light smokers, intermittent smokers or social smokers. While forming such groupings may be scientifically useful, there are not standardized definitions for group membership, leading to a lack of clarity and comparability across studies. In tobacco research, groups are commonly formed via cutoff scores. That is, if one is below a certain score, one is in group A, otherwise one is in group B. However the lack of clear group definitions has lead to different researchers using different cutoff scores. For example, one researcher may use smoking five or fewer cigarettes a day as a cutoff to define the "light smoker" group, where another researcher may use smoking ten or fewer cigarettes a day to define the same group. A further potential weakness of the use of cutoff scores is that they enforce absolute distinctions and thereby ignore within group variability as well as measurement error. Rather than using cutoff scores to de-

fine groups, we can use statistical models, such as latent class analysis (LCA), to empirically group observations. LCA is a multivariate statistical model often used for exploratory analysis, It identifies homogeneous subgroups (or classes) in a population on the basis of item associations. The purpose of this study is to compare group differences between groups formed via cutoff scores with groups from LCA. The question of interest is if results in these analyses differ or parallel each other. Specifically, we examined the differences in the associations between group membership and relevant demographic covariates as well as measures of nicotine dependence.

POSTER SESSION 4

MGH 241, Easel 143

4:15 PM to 5:45 PM

The Effect of Paraquat on the Replicative Life Span of Yeast

Jane Jeehyun (Jane) Kwon, Senior, Biology (Molecular, Cellular & Developmental), Biochemistry
Janice Shi Mei Khoo, Senior, Biology (Physiology)
Malika Jhawar, Junior, Psychology
Mentor: Matt Kaeberlein, Pathology
Mentor: Brian Wasko, Department of Pathology

Aging in the budding yeast *Saccharomyces cerevisiae* can be measured by its replicative life span, which is defined by the finite number of mitotic divisions of mother cells. The Kaeberlein lab measures the replicative life span of *S. cerevisiae* through the microdissection of dividing mother cells. This laborious process separates daughter cells from their mothers, which quantifies the replicative life span. We are assessing how various environmental factors affect the replicative life span of the cells. Our research project involves paraquat, a commonly used pesticide that produces reactive oxygen species within cells. This substance is normally considered to be toxic, and as expected, we have observed that the replicative lifespan of yeast is decreased in the presence of high concentrations of paraquat. However, we have also found that low concentrations of paraquat increased the replicative life span of the yeast. This observation is an example of hormesis- a phenomenon where beneficial effects are obtained at low doses of an agent that is otherwise toxic when given at higher doses. These findings are significant because a similar effect has been published with the nematode worm, *Caenorhabditis elegans*. *C. elegans* and *S. cerevisiae* are evolutionarily separated by approximately one billion years, suggesting that there is a conserved mechanism of life span extension influenced by paraquat. We are currently characterizing the effect of paraquat and other environmental conditions that will help us to find conserved pathways that modulate longevity.