SCHOOL OF SCIENCE AND MATHEMATICS

Undergraduate Research Poster Display

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Note: The names of Millersville University faculty advisors are designated by an asterisk (*) in the abstracts.

Biology

1. Subcloning Candidate Suppressor Genes Involved in Restoring *HOT1*-dependent Recombination in *deg1* Mutant Yeast

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Genetic recombination is essential for maintaining genome sequences in all organisms. It also helps to create novel alleles and gene combinations that drive evolution. Despite its importance, mechanisms of recombination are not completely understood. Easy culture and genetic flexibility allow the yeast *Saccharomyces cerevisiae* to serve as an excellent experimental model for all eukaryotic organisms, including humans. *HOT1* is a recombination hotspot within the ribosomal RNA genes of yeast. It appears to be important for maintaining the integrity of these repeated genes, but its precise role and the enzymatic pathways involved are not fully understood. In *S. cerevisiae*, the *DEG1* gene is needed for *HOT1*-dependent recombination and normal growth. Mutants defective in *DEG1* are temperature sensitive and exhibit lower rates of mitotic recombination. The product of *DEG1* is a pseudouridine synthase that modifies tRNA molecules, and the connection between this activity and genetic recombination is obscure. In an attempt to understand how *DEG1* impacts recombination, a search was made for yeast genes that can suppress growth defects of *deg1* mutants. One segment of the wild-type genome was identified as an effective suppressor, and DNA sequencing revealed that it contains three distinct genes. To identify which of the three is the true suppressor, these candidate genes were separated from each other using restriction enzymes or the polymerase chain reaction (PCR) and then isolated using gel electrophoresis. Each was inserted separately into the expression shuttle vector YCpLac118 and then transformed into bacterial cells. Successful subcloning was verified using restriction enzyme analysis. To determine if it has an effect on growth and recombination rates in yeast, each gene will be transformed into mutant *deg1* cells for evaluation. Understanding the role of genes involved in recombination will enhance our understanding of the process and may provide insight into cancer and other genetic diseases.

2. Antibody Attachment to Nanowire Arrays

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A new approach in the development of sensors that will detect extremely small concentrations of analytes such as hormones or cancer indicators in blood and other fluids very rapidly, is one that utilizes nanotechnology. In this approach, very small structures such as nanowire arrays need to be coated with active antibodies directed

against the compounds to be analyzed. It is the purpose of these experiments to measure the degree of antibody attachment under various conditions. We have previously attached antibodies made against an indicator for ovarian cancer (CA 125) to nanowire arrays provided by Illuminex Corporation. These arrays are groups of parallel wires measuring approximately 80 nanometers by 120 nanometers attached to a glass substrate. Through a series of chemical reactions using MUA (11-mercaptoundecanoic acid) side arms and spacer molecules, the antibodies are covalently attached to the nanowires. In order to find the amount of antibody binding to the arrays, a fluorescein labeled second antibody was incubated with the functionalized wires. This incubation led to an emission of fluorescence. The degree of fluorescence detected is proportional to the amount of antibody attached to the nanowires and was approximately $9X10^{-4}$ ug of antibody per mm^2 of nanowire array. It was the purpose of this study to determine which spacer molecule gave optimal antibody attachment. The spacer molecules tested were 6-mercapto-1-hexanol, 4-mercapto-1-butanol, and 1-octanethiol. Once we found 4-mercapto-1-butanol gave the greatest fluorescence, we attempted the antibody attachment with a variety of MUA to spacer molecule ratios and found no significant difference in the antibody attachment with various amounts of spacer. These studies have led us to establish the optimal conditions for covalent linkage of antibody to nano structures.

3. Contributions to the Natural History of Lancaster County: The Botany of Mary Emma Groff

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The James C. Parks Herbarium at Millersville University recently became the recipient of a large collection of pressed herbarium specimens from the late Mary Emma Groff, an amateur botanist who collected plants in Lancaster County and the surrounding areas between the years of 1930-1965. We databased and georeferenced her nearly 3,000 specimens and 1,834 species, subspecies, varieties, and hybrids using electronic gazetteers. We found that Groff's collection represents nearly 30% of Pennsylvania species, and 60% of species found in Lancaster County. Additionally, a number of these specimens were found to be of species currently threatened, rare, extirpated, or otherwise previously unknown in Lancaster County. Here we investigate the potential of this important collection to help document the last known occurrences of plant species of special concern and to help target conservation efforts.

4. New Species of Chimaeriod Fishes from Australia

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The chimaeroid fishes, also commonly known as chimaeras or ratfishes, are an ancient group of deep-sea fishes related to sharks. We have described two new species of

chimaeroid fishes from the family Chimaeridae. The fish are described on the basis of morphological features and geographic range. The Chimaera Sp. A is a medium to large-bodied species of *Chimaera* distinguished by an easily flaking deciduous skin that is a silvery color when it is fresh and fades to a light yellowish brown color after it is fixed and a dorsal fin spine that is longer than the first dorsal fin. This chimaera ranges from Tasmania, along the South Australian coast, to Southwestern Australia at depths of 400 to 1028 meters. The Chimaera Sp. B is a medium bodied species of *Chimaera.* It also has easily flaking deciduous skin though it has a darker brown color that fades ventrally. It is also distinguished from the Southern chimaera by a dorsal fin spine that is usually shorter than the first dorsal fin. This species occurs off the coast of Southeastern Australia from Southern Australia to Tasmania at depths of 600 to 1100 meters. The ratios of the length of the dorsal fin spine (DBA) to the head length (HDL) are statistically different between the two species. These species have been regarded as new species by other works (Last and Stevens, 1994), and formal taxonomic recognition of this species will prove important for fishery management.

5. Comparison between Marine Zooplankton Species and Abundance in the Chesapeake Bay Plume versus the Adjacent Atlantic Shelf

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We are comparing the common zooplankton taxa and their abundance between the nearshore Chesapeake Bay plume and adjacent Atlantic shelf. Lower salinity water flows from the Chesapeake Bay into the higher saline coastal water, and is a factor in the density and occurrence of various taxa. Zooplankton were collected during a cruise from July 2-6 aboard the Research Vessel (R/V) SHARP. At four stations in the plume and four stations in the adjacent shelf, samples were collected using vertical net tows with 80 um mesh. Closer to the estuary in the Chesapeake Bay plume, we saw an increase in benthic larvae, but a decrease in salp and dolioloid populations which were found farther offshore. We have found thirty marine zooplankton species and taxa such as copepods, polycheate larvae, hydrozoan medusae, chaetognaths, lancelets, appendicularians, doliolids, zoea crab larvae, shrimp and fish larvae, and siphonophores. The abundance of marine zooplankton and their distribution along the Chesapeake Bay plume and coastal region is useful to document indicator species such as hydrozoan medusae which have become more abundant in the last decade due to warming trends, life cycles of benthic species which have larval stages that grow up in the coastal ocean, and abundances of herbivorous zooplankton which may control phytoplankton blooms.

6. Raman Spectroscopy of Proteins for Biosensor Applications

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Raman spectroscopy is a young field in biomolecular analysis that has been researched substantially to indicate its potential in future biomedical advances in technology. When light energy collides with a molecule, a scattering of photons occurs. Raman scattering occurs when the light energy scatters at a different frequency than it had before the collision occurred. A molecule's vibrational transitions allow for the "fingerprinting" of that molecule using Raman spectroscopy. Raman spectroscopy can be used to measure particular bonds in a molecule since the Raman peaks are spectrally narrow. However, this signal can be greatly enhanced in the presence of nanostructures (less then 60nm) such as nanowire arrays. For this reason, the use of Raman spectroscopy in medical diagnosis is under study. Bovine albumin, both in solid and liquid form, was analyzed in the Raman Spectrometer and analyzed for distinguishable Raman bands. Concentrations as low as 1.25mg/ml were measured using quartz cuvettes and concentrations as low as 0.39mg/ml were measured using nanowire array substrates. A chemical "fingerprinting" of the bovine albumin could be visualized on the Raman spectra with the most distinguishable peak occurring at ~1000cm^{-1}. Surface enhanced Raman signals were seen when using nanowire arrays, enhancing Raman peak intensity and natural albumin fluorescence. Bovine serum albumin was then analyzed to observe if similar Raman bands would occur in comparison to the bovine albumin spectra. Indications of bovine albumin in the serum could be seen on spectral analysis. This showed that macromolecules such as albumin could be visualized in solution mixtures. There is a particular importance involved with protein detection for biosensors applications.

7. Seasonal Fluctuations in the Xanthophyll Cycle of the Deciduous Tree, *Acer platanoides*.

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Seasonal and daily fluctuations in the xanthophyll cycle of a deciduous tree, the Norway maple, *Acer platanoides*, were investigated in this study. The xanthophyll cycle is a mechanism involving three carotenoid pigments, the xanthophylls, and serves to dissipate excess light energy. Plants use light energy to convert carbon dioxide into sugar in a process called photosynthesis, however excess light energy can be harmful to plant tissues. This study sought to determine if the concentration of xanthophylls changes over the course of a growing season in response to natural fluctuations in light conditions. This was accomplished by measuring carotenoid concentrations in *A. platanoides* leaves collected once a week at noon and midnight from April to October 2006. Concentrations were obtained through ethanol extraction followed by spectrophotometric analysis, in which extract absorbencies were measured at 664, 649, and 470nm. In addition, daily fluctuations were observed by measuring carotenoid concentrations every two hours on

the east, west, and south sides of the same *A. platanoides* tree over 24 hours. Seasonal and daily light conditions will be compared to corresponding fluctuations in carotenoid concentrations to observe any possible correlations. Understanding how plants protect themselves against light stress is important to horticultural and agricultural systems. This research was supported through a CPUB grant and Millersville University.

8. Applicability of PCR Methodology in Identification of Sex-Specific Genomic Sequences in *Octopus bimaculoides*

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In many animals, physical differences between males and females occur because of differences in their chromosomes. For example, the inheritance of male-specific genes on the Y chromosome of mammals programs a normal individual to become male. While common, this is not the only mechanism for sex determination. Environmental triggers determine whether genetically identical individuals develop as males or females in some species. The incubation temperature of eggs during early development determines sex for many reptiles. In *Octopus bimaculoides*, distinct males and females exist with internal reproductive organs that can be distinguished definitively only during post-mortem dissections. Although this octopus is widely used for behavioral studies, the basis for its sexual dimorphism is not known. Sex chromosomes have not been identified in octopuses, but sex-specific genomic DNA sequences could account for differences observed between the sexes. To investigate this possibility, genomic sequences isolated from adult octopuses were analyzed using polymerase chain reaction (PCR) -based techniques. Good quality high molecular weight DNA was isolated from arm muscle stored in 70% ethanol. Following proteinase digestion, tissue homogenate was treated with either phenol/chloroform or concentrated salt solution followed by chloroform extraction to dissociate high molecular weight DNA from chromosomal proteins. DNA was concentrated by alcohol precipitation and then analyzed using two distinct PCR methods, Randomly Amplified Polymorphic DNA (RAPD) or Amplified Fragment Length Polymorphisms (AFLP). PCR products were separated according to size using electrophoresis on agarose or polyacrylamide gels. The DNA profiles generated were compared to evaluate the reproducibility and effectiveness of various methodologies. The identification of sex-specific genetic differences would enable a non-invasive method of sex determination that will facilitate behavioral investigation and should provide insight into sexual development in cephalopods.

9. Sexual Risk and Behaviors Among MU Students

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Adolescents, aged 15 to 24 years of age, experience the highest incidence of STIs in the USA. Annual averages of Chlamydia, gonorrhea, and syphilis are at high numbers. Re-infection and risk perception have been implicated as reason for high numbers of STIs among children less than 18 years of age. These results have not been validated among college students. Determinants of partner re-infection and markers of health seeking behavior in this age group are dynamic and not fully examined. The purpose of this study was to characterize partner notification, risk perceptions and health seeking practices among college students in Pennsylvania. A survey was constructed and approved by the Millersville University IRB. The survey was then loaded onto an online survey site (QuestionPro). An email was sent out to 6,940 MU students with a link to the survey, and all data were compiled without record of names or emails. One thousand and nine surveys were completed and tabulated. Fifty percent of the students completing the survey stated that they had vaginal sex without a condom. Only 39% of students said they use a condom for 75-100% of their sexual encounters, while -75% of students do not consider themselves at risk for contracting an STI or HIV, and have never had an HIV test. This information will help inform public and school health programs on how to help youths adopt positive and protective sexual health behaviors.

Chemistry

10. Synthesis and Characterization of Copper Nanowires

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The synthesis of copper nanowire arrays using a templating process is being presented. The self-assembly property of aluminum is used during anodization when aluminum metal forms an oxide template of nanoscale cylindrical pores. These pores are filled with copper metal to form nanowires. The oxide template is then etched away in an acid bath. The resulting copper nanowire arrays are characterized with scanning electron microscopy. Results of anodization step-down voltage experiments will be presented.

11. Atomic Force Microscope and UV-Visible Spectroscopy Studies of Nanoscale Films

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Nanoscale polylectrolyte films were prepared on Au coated glass slides modified with 2-mercaptoethylamine (MEA-$H_2NCH_2CH_2SH$) and quartz glass slides functionalized with 3-aminopropyltriethoxysilane (APTMS-$H_2N(CH_2)_3Si(OCH_3)_3$. The films consisted of alternating layers of (sodium 4-styrene-sulfonate) (PSS) and poly(allylamine hydrochloride) (PAH). These ionic polymers are oppositely charges and form bilayers due of electrostatic attractions. Blank slides were compared to the slides with the thin films using an Atomic Force Microscope (AFM) to image their surfaces. Differences in the surface structure, height and surface roughness were observed, indicating that a thin film developed. Growth of the films on a quartz glass slide was followed using an Ocean Optics photodiode array spectrometer. An increase in absorbance was observed after adsorption of each layer. The nanoscale films prepared are of interest in many applications including development of sensors, drug delivery and catalysis.

12. Electroroughening and Functionalization of Nanowire Arrays for the Development of a Biosensor

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As part of an initiative to develop a biosensor for the detection of ovarian cancer using nanowire arrays, gold and silver nanowires are cleaned and roughened using electrochemical techniques and functionalized with a self-assembled monolayer. Cleaning of the wire arrays removes impurities from the array surface to facilitate functionalization, while roughening increases the analytical signal obtained. The gold and silver arrays were run at several ranges of applied voltages to determine their respective optimal voltages and characterized using scanning electron microscopy. The gold and silver arrays are then functionalized with a self-assembled monolayer consisting of mercaptoundecanoic acid and a spacer molecule. The acid of the monolayer acts a site to which antibodies specific for ovarian cancer antigen can bind, while the spacer ensures that the antibodies have the room to correctly bind. Fluorescent microscopy was used to determine an optimum spacer molecule and ratio of spacer to acid molecules required to produce the greatest active antibody attachment.

13. The Color Effects of Chemical Patinas on Copper

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This cross-disciplinary study is designed to create a palette of color effects on the surface of copper, known as patination, by the application of various chemical solutions to the copper surface. A major goal of the study is to optimize and control the length of time needed to produce specific colors, as well as to produce a method of "painting" on copper metal without the need to use traditional paint. We found that there are two primary types of colors produced, luster and matte colors. We treated 1" x 1", 20 gauge copper samples with five different chemical solutions using various application techniques, and analyzed each treated sample by light microscopy, infrared spectroscopy (IR), and Raman spectroscopy. We also examined selected samples using scanning electron microscopy (SEM). We were able to produce a wide range of colors and surface effects ranging from blues, to greens, to reds, to yellows, and grays. The surface of the treated copper revealed visible crystalline structures for the matte colors as well as evidence of multiple layering for the luster colors.

14. Metal Coated Nanoparticles and Surface- Enhanced Raman Spectroscopy for the Detection of Low Concentrations of Perchlorate Ion in Water

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Perchlorates are used in rocket fuel, fireworks, and fertilizers, and have been linked to neurodevelopment problems in infants, resulting in attention deficits and low IQ scores. In order to detect trace amounts of perchlorates, a technique called Surface Enhanced Raman Spectroscopy, or SERS, is being used. SERS involves making solutions of silica spheres, about 500 nm in diameter, and coating them with a layer of gold. The Raman Spectrometer uses a laser source that interacts with the sample of interest and measures the light that is scattered. Gold-coated spheres allow one to detect even lower concentrations of ions than normal because the roughness of the gold coating increases the light signal emitted from the sample being analyzed. The goal of this project is to find a way to detect the smallest possible amount of perchlorate ion. To reach this goal, silica spheres were made using slightly different techniques, such as adding more catalyst or allowing the spheres to react for a longer period of time. Once spheres are made that maximize the detecting capabilities of the Raman Spectrometer, they will be used to detect small concentrations of perchlorate ion. This technique can be more efficient and cost-effective than previous methods of detection and will make environmental testing much easier.

Computer Science

15. Research into Developing 3D Game Programming Toolkits Using OpenGL™ and DirectX™

Billman, Chad (MU 2006); Bush, Matthew (MU 2006); Harris, Matthew (MU 2006); Hollinger, Jonathan; Waldon, Steve (MU 2006); Barr, Matt; Adams, Cory; Webster, Roger, Ph.D.* and Zoppetti, Gary M., Ph.D.*
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Developing a 3D video game or graphical application using the OpenGL or DirectX API's can be daunting. To facilitate development, we have created toolkits for OpenGL™ and DirectX™ that abstract away many of the low-level details and provide enhanced functionality. For example, both of the MU developed toolkits (MUopengl Toolkit and MUDirectX Toolkit) provide easy to use programming objects such as: a camera, a moveable class with MoveForward(), MoveBackward(), MoveX(), MoveY(), MoveZ(), Pitch(), Roll(), Yaw(), positional 3D sound, 3D Studio model loading, skybox objects, billboard objects, animated TGA textures with alpha channel support, Cal3D animated characters with quaternion interpolation, MD3 quake animated characters, explosion objects, particle systems for smoke, fire, fog, and simple fluid dynamics, a weapons class, and collision detection classes. The toolkits also have an extensive library of easy to use object oriented vector and matrix operations. In addition the toolkits have network objects allowing the programming easy to use object oriented network packet sending to allow the games developed to be played over the internet with up to 8 people playing highly interactive, fast, 3D first person shooter games. The OpenGL toolkit has been used successfully for over five years in the undergraduate courses: CS375 3D Graphics and CS475 Game Development and Computer Animation. These toolkits allow students to focus on programming the game play, computer animation, artificial intelligence, and overall compelling 3D virtual world interaction. The success of the OpenGL toolkit inspired the creation of a complement toolkit using DirectX 9. Demos of the games and more information can be found at:
http://cs.millersville.edu/~webster/gametechnologytrack/resources.html.

16. An Interactive, Web-based Atlas for the Woody Vines of Pennsylvania

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We are developing an interdisciplinary (Computer Science and Biology) interactive, Web-based atlas in order to better document and monitor the distributions of the 38 species of woody vines of Pennsylvania. This small element of the Pennsylvanian flora will be a test case for a much larger atlas for the state or larger geopolitical entity. The approach integrates the general mapping services provided by Google Maps™ and

locality data provided by the James C. Parks Herbarium or reports by students and citizens. Currently, distribution mapping, environmental monitoring, and conservation efforts relying on large quantities of up-to-date locality data for plant species are limited by the relatively small community of professional biologists already engaged in such activities. We believe that professional biologists are not the only possessors of quality information on plant distributions; thus, allowing contributions of locality data from the lay community may improve our ability to document and monitor plant distributions, especially in the light of potentially rapid climate change in the next few decades. Given the concern over "data quality" where laypersons are involved, as our atlas grows we will investigate (i.e., quantify) the general accuracy of user-contributed data using novel ground-verification projects integrated into the classroom and work-study activities of undergraduates. These “quality checks” on contributed locality records should provide the first evaluation of the efficacy of such science-lay community collaborations in the study of biodiversity and its conservation.

17. Wireless Networking Securities

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Wireless Networks are prevalent and more people are beginning to use these networks for portable communication. We concentrate on wireless networks that are based on the IEEE 802.11 standard and the security measures that can be taken to protect such networks from information leaks. Wireless networks present a whole new landscape of security flaws and vulnerabilities; while they offer the unparalleled ease-of-access and portability, this advantages also comes with its shared of security threats. Because wireless signals can be picked by anybody with a capable device, wireless networks are prime targets for exploits. The thesis examined the main security procedures for securing a wireless network. Among this examination was an audit of institutions, including Millersville University, that currently use wireless technology. Brad “cracked” the currently implemented wireless security of the institution (with permission) in hopes of determining the best methods for securing their wireless network. In conjunction with the penetration testing, the implementation costs of each type of security, the ease of implementation of each type of security, and the hindrance to the end user of each type of wireless security was also examined. The types of security methods that were researched included, but are not limited to, different types of encryption (WEP, WPA) and captive portal. The conclusion of his research was the overall wireless security plan for each institution that will assess security needs, budget, implementation, types of users, and maintenance.

18. An Interactive, Web-based Informational Database and Key for the Woody Vines of Pennsylvania

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As a test-case for larger projects, we are constructing an online interactive guide to the 38 species of woody vines of Pennsylvania. We are developing the database backend using MSSQL, a relational database management system, and user-interface and database query functionality using PHP and HTML. The main page consists of a list of characters with radio-buttoned lists of character states that can be selected by users in order to search for species in our database that meet user-specified criteria (i.e., which woody vines have opposite leaves with green flowers?). Once the list of species is winnowed down, a page profiling each species of interest can be visited at which information on the appearance and ecology of each species can be found. We expect our database and key to grow rapidly since contributions of data and images will not be limited to scientists, rather open to both scientists and interested non-scientists. In a since, we model our approach after that taken by the online encyclopedia "Wikipedia."

19. Extending the Personal Portable Profile Project

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The purpose of the Personal Portable Profile project is to allow users to transfer personal, accessibility-related settings between computers easily and effectively. The program is written in C#.NET, using the Visual Studio 2005 application programming environment.

The program now captures, sets, and restores additional settings. Some examples include FilterKeys, cursor blink rate, cursor width, and mouse lock. Two Win32 system calls handle the cursor blink rate. Because Win32 functions are written in C++, which uses unmanaged types, methods from the .NET Framework's Marshal class were needed to convert between C#'s managed types and C++'s unmanaged types. Unmanaged types require explicit memory allocation and deallocation.

We are adding support for U3 smart drives (a type of flash drive). The U3 software development kit enables applications to be run from a smart drive through an interface modeled after the Windows XP start menu. By creating a U3 package from the profiler program, we enable a user to launch the application directly from the smart drive using a familiar interface. Soon we will also investigate the system's compatibility with Windows Vista.

20. Extending 3D Meteorological Data Visualization in IDV

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The Integrated Data Viewer (IDV) from Unidata is a Java™-based software framework for analyzing and visualizing geoscience data http://www.unidata.ucar.edu/software/idv/). It uses an analysis and visualization component called Visualization for Algorithm Development (VISAD), which itself is built upon the Java™ 3D application programming interface.

IDV requires the user to probe data from outside the data volume. Instead of leaving the virtual viewer stationary, we allow the user to navigate and probe the dataset simultaneously. This proves much more intuitive and allows the viewer to "experience" points of interest.

While exploring a dataset, the user often desires to launch a dropsonde/upsonde to view a vertical profile of weather data immediately below/above the probe's location. IDV provides class VerticalProfileControl which gathers dropsonde and upsonde data for a given location. We opted to use this functionality to obtain a more complete survey of the data. While the viewer is coincident with the data probe, he will be able to perform a comprehensive data sounding and move along the profile, allowing individual points to be more closely examined.

Future work includes path logging as well as adding realistic animations for the activation of a vertical profile. We also plan to leverage IDV's new plug-in architecture to integrate our additions, rather than modifying the base IDV code.

21. Developing Labs to Support an Undergraduate Robotics Curriculum Using the Java iCommand API

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The goal of this research is to develop lab exercises for use in an upper-level robotics elective. Using the Lego Mindstorms® NXT kit in conjunction with the Lejos iCommand API, several labs were developed in Java. These labs are designed to reinforce the topics and theories presented in the textbook "Introduction to AI Robotics" by Robin Murphy and have been adapted from labs developed by Aaron Gage and Robin Murphy to utilize the iCommand API and the expanded capabilities of the new NXT platform.

22. Integrating the Simulation of Physical Systems into the MUDirectXToolkit

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This project extends three semesters of development of a real-time simulation toolkit utilizing the Direct3D graphics library. The MUDirectXToolkit is an ensemble of optimized object oriented classes, written in C++ and High-Level Shading Language (HLSL), which allows real-time simulation, with particular attention on performance. The toolkit renders millions of elements at a rate greater than 30 frames per second.

This semester we added support for rigid- and soft-body physics simulations to the MUDirectXToolkit using the Ageia PhysX library in conjunction with a dedicated Physics Processing Unit (PPU). The physics engine performs computationally expensive simulations of objects in a virtual universe. We use PhysX to model gravity, friction, collisions, rotational dynamics, cloth, and fluids. Complex rigid bodies are approximated by bounding spheres, boxes, and user-defined convex shapes, which the physics engine is optimized to handle. The toolkit generates these volumes which correspond to objects in the rendering pipeline, including perspective viewports and lights. Physics resolution can be increased with compound shapes and joints with up to six degrees of freedom. MUDirectXToolkit models cloths which move, tear, billow, and drape in response to forces. It also includes Computational Fluid Dynamics (CFD) modeling, a compute-intensive process requiring the PPU to simulate particle behavior. Hardware acceleration enabled us to simulate puddles and fountains which part and coalesce.

Integration of the physics engine into the MUDirectXToolkit enables developers to create real-time simulations with realistic physics and high performance.

23. A Browser Extension for Providing Visually Impaired Users Access to the Content of Bar Charts on the Web

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Information graphics, such as line graphs, bar charts and pie charts, play an increasingly important role in our documents. If some members of the audience cannot perceive these graphics, they miss out on the message that these information graphics were utilized to convey. Not being able to access that information puts them at a severe disadvantage. In the realm of computing, we can reduce this handicap for blind users by using software that hypothesizes the intended message of an information graphic and produces a textual summary of the graphic.

In order to assist blind users in their web browsing in this manner, we created a Browser Helper Object (BHO) that would run inside of the Internet Explorer web browser and interface with a system that infers the intended message of a bar chart (this system was created by Dr. Elzer and researchers at the University of Delaware). The BHO is also designed to work well with JAWS, a popular screen reading software package for blind users, or screen magnification software such as ZoomText. Users select a bar chart using keyboard commands and activate the BHO with a designated keystroke. After the intention recognition system generates a textual summary, the BHO displays the summary. The summary can then be read aloud by JAWS or magnified by text magnification software.

User evaluations were performed to assess 1) the ease of use and utility of the interface (the BHO), and 2) the effectiveness of the textual summaries generated by the intention recognition system. The results from these evaluations are presented, along with screen captures and examples of the system output.

24. Network Security and Forensics in Financial Institutions

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The security of computer networks has necessarily become of paramount concern. Financial institutions rely heavily on these networks, and the personal and financial data that travels over them is often vulnerable to attack. Hackers can attack locally or remotely by using software, the Internet, or by employing social engineering. If an attack occurs, it is the goal of computer forensics to identify the attack, collect evidence, and analyze it in the at-tempt to capture the perpetrators. Using various methods, it may be possible to prevent future attacks. Network security methodology can provide a logical and effective guideline to actions that should be taken by financial institutions to limit vulnerabilities and prevent attacks. These include an established security baseline, education of the employee, and a documented and enforced security policy. Network services should be hardened, and software must be audited and properly configured. A case study of a Windows 2000 server will demonstrate how software vulnerabilities exist and must be protected. To win the war against hackers, financial institutions must physically and technologically secure their network infrastructure and the customer information it encompasses.

25. Using an Approximation to the Euclidean Skeleton for Efficient Collision Detection and Tissue Deformations in Surgical Simulators

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This paper describes a technique for efficient collision detection and deformation of abdominal organs in surgical simulation using an approximation of the Euclidean skeleton. Many researchers have developed surgical simulators, but one of the most difficult underlying problems is that of organ-instrument collision detection followed by the deformation of the tissue caused by the instrument. Much of the difficulty is due to the vast number of polygons in high resolution complex organ models. A high resolution gall bladder model for instance can number in the tens of thousands of polygons. Our methodology utilizes the reduction power of the skeleton to reduce computations. First, we recursively compute approximations to the Euclidean skeleton to generate a set of skeletal points for the organ. Then we pre-compute for each vertex in each polygon the associated skeleton point (minimal distance discs). A spring is then connected from each vertex to its associated skeleton point to be used in the deformation algorithm. The data structure for the organ thus stores for each skeletal point its maximum and minimum distances and the list of associated vertices. A heuristic algorithm using the skeleton structure of the instrument and the skeleton of the organ is used to determine instrument collisions with the organ.

26. A Didactic Training Simulation System for the Curvilinear Capsulorhexis Cataract Procedure on the EYESI™ System

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This presentation describes a technique for didactic training and simulation of the capsulorhexis procedure during cataract surgery on the EYESI™ system. Eye surgery necessitates sub-millimeter precision and demanding hand-eye coordination in a very small workspace, thus making it difficult to simulate. Some researchers have developed eye surgical simulators, but none have attempted to model the capsulorhexis procedure during cataract surgery. The continuous curvilinear capsulorhexis technique can be a difficult procedure for beginning ophthalmology surgeons. In the initial phase of tearing the tissue, the tear vector is tangential to the circumference of the tear circle. However, without the proper re-grasping of the flap of torn tissue close to the tear point, the tear vector angle quickly runs downhill possibly causing severe damage to the tissue. Novice surgeons tend to try to complete the capsulorhexis without the time consuming re-grasping of the tissue flap. Other factors such as anterior bowing of the lens diaphragm, patient age, and shallow anterior chambers add to the problematic nature of the procedure. The tissue area is modeled as a curvilinear mesh of nodes and springs. Deformation is accomplished via a physically based particle model utilizing a heuristic algorithm to constrain the deformation calculations to the locality of the tear area to speed up computations. The software alerts the user of any potential tear problems before they occur thus instructing the novice surgeon. For example, as the user approaches the 12

o'clock position the tear vector *unintuitively* begins to run peripherally. If the surgeon attempts to redirect it by traction directed in a radial fashion toward the center of the lens, the tear only propagates further peripherally (runs downhill). Continuing to try to redirect the tear can cause severe damage to the tissue in an actual patient. The EYESI™ hardware system provides the user with stereoscopic images thus providing 3D viewing. Our capsulorhexis simulator software models various tear problems and anomalies to provide a useful didactic training environment without the dangers of using live patients.

Earth Sciences

27. Correlation of Meteorological Variables and Major League Baseball Home Run Statistics

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Our research examines correlations between game-time meteorological variables and hitting statistics for America's favorite pastime. The meteorological variables used in the analysis include: temperature, dew point, pressure, and long-wind (toward center field) and cross-wind components. Hitting statistics include: home runs per at bat, home runs per hit, and the percentage of home runs to left, right, and center fields. The data were gathered for every open-air, major-league baseball stadium during the 2006 regular season. Scatter plots were then constructed between combinations of the meteorological variables and hitting statistics for each stadium, and for all stadiums combined.

28. Investigation of Geostrophic Adjustment and the Evolution of Anomalous Atmospheric and Oceanic Circulations, using a Shallow-water Model

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We developed a one-dimensional shallow-water model to simulate the adjustment of a constant density fluid in a rotating reference frame, and applied a modified version of the model to flow fields which occur in the atmosphere and oceans. The model is programmed in the Interactive Data Language (IDL) and uses standard finite-difference techniques. The model includes radiative boundary conditions to allow waves to traverse out of the model domain with minimal reflection. The model correctly simulates the geostrophic adjustment process, resulting in small-scale disturbances adjusting the mass field to the initial velocity field and large-scale disturbances adjusting the velocity field to the initial mass field. One goal is to have an easy-to-use model that can be used in a

classroom setting to demonstrate important large-scale adjustment process that occur in the atmosphere and oceans. We also generated a second version of the model, using cylindrical coordinates, to simulate adjustment in axisymmetric circulations. The model accurately initializes and maintains balanced ordinary circulations which commonly occur in the atmosphere and oceans. It also supports balanced anomalous flows that are mathematically possible but rarely observed. We explored the adjustment that takes place when circulations are perturbed from a balanced state, in order to gain insights into the formation and evolution of anomalous circulations. In some cases, perturbations caused regular high circulations to transform into anomalous high or anomalous low circulations.

29. Muscovite Weathering in the Brubaker Run Watershed Regolith

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Chemical weathering of bedrock minerals dictates the nutrients found in soils. Macronutrients such as K^+, Ca^{2+}, and Mg^{2+} are needed in large quantities to develop healthy biomass. Bedrock plays a vital role in determining the quality of soils for agriculture and ecosystems. The location where bedrock minerals are chemically destroyed is termed the "critical zone." This zone is a complex interaction of water, soil, rock, air, and living organisms that breakdown elements so biomass can uptake the nutrients. The purpose of this study is to determine where in the critical zone of the Brubaker Run watershed is the chemical destruction of the K^+-bearing mineral muscovite occurring.

To determine where the minerals are weathering in the regolith, thin sections of the bedrock, saprolite, and soil were prepared and viewed. The mineral content of each slide was evaluated by point-counting. Thin section observations indicate that the bedrock is heterogeneous, containing quartz (31%), muscovite (38%), chlorite (25%), garnet (0.8%), REE-rich epidote (1.5%), and calcite (1.2%) minerals. In the saprolite, calcite, REE-rich epidote, and garnet are completely dissolved, and chlorite is extensively weathered. Muscovite and quartz are the only bedrock minerals found in the soil thin sections. Because the only macronutrient hosted by muscovite is K^+, the Brubaker Run ecosystem is Mg^{2+}- and Ca^{2+}-limited. This has strong implications for the agricultural resources of the area.

30. Integrating Linked Environments for Atmospheric Discovery (LEAD) Research in Education

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Linked Environments for Atmospheric Discovery (LEAD) is making meteorological data, forecast models, and analysis and visualization tools available to anyone who wants to interactively explore weather as it evolves. The LEAD education and outreach initiative is aimed at bringing new capabilities into the classroom for the middle school level through graduate education and beyond. One of the principal goals of LEAD is to democratize the availability of advanced weather technologies for research and education. Undergraduate students have the opportunity to query observational data and model output, and explore and discover relationships through concept mapping using an ontology service. Furthermore, they can select domains of interest based on current weather, and employ an experiment builder within in the LEAD portal as an interface to configure, launch the WRF model, monitor the workflow, and visualize results using Unidata's Integrated Data Viewer (IDV), whether it be on a local server or across the TeraGrid. For pre-college students, a basic version of IDV is being developed by the National Center for Supercomputing Applications Cybereducation group (NCSA), with the goal of enabling students to model weather phenomena, create basic forecasts, and in general, understand the field of meteorology through a constructivist approach. In addition, the LEAD portal will contain a rich list of resources (i.e., lesson plans and learning modules) for both educators and students at the pre-college level. Another important goal of the LEAD education and outreach initiative is the LEAD-to-LEARN modules, which enable both undergraduates and pre-college students to understand various topics in meteorology through a hands-on approach.

31. A Climatology of Marine Meteorological Phenomena in the Alaska Region using Synthetic Aperture Radar

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The Alaska region offers a wide range of mesoscale and microscale marine meteorological phenomena. These phenomena include gravity waves, convection, island wakes, convective roll vortices, and gap flows. Each phenomenon require distinctly different wind shear and static stability regimes. The surface signatures of the above-mentioned phenomena are readily detectable in high-resolution synthetic aperture radar (SAR) imagery of the sea surface. Using an archive of over 30,000 SAR marine images of the Alaska region, we have developed frequency climatology of the above mentioned phenomena. NCEP/ NCAR reanalysis data have been employed to provide a corresponding climatology of wind shear and static stability conditions associated with each phenomenon.

32. Lasers in Secondary Physics Education

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The goal of this research topic is how a laser pointer can be used to explore theories such as diffraction, image transformations, light intensity distribution, solid state and gas state laser physics. The experiments conducted are meant to be simple and easily implemented into the high school physics classroom; but the underlying concepts discussed above carry ever more into the more advanced realm of physics. My first experiment used a green and red laser pointer to observe diffraction and calculate the track spacing between pits and lands of a compact disc. For the red laser pointer, wavelength (650 ± 10) nm, the track spacing d was found to be (1.58±0.08) μm and for the green laser pointer, wavelength 532 nm, d=(1.55±0.06) μm. Not only does this involve the use of calculation, it creates classroom pedagogy discussing the idea of diffraction. Also of interest is the design and construction of a laser pointer and how this affects the properties of the laser light. It is noticed that most lasers operating in a mode of TEM_{00} do not have a uniform distribution of intensity within its beam. Instead, it is known that the intensity has a Gaussian distribution, which is represented by $I(x) = I_0 e^{\frac{-2(x-x_0)^2}{w^2}}$, where the intensity is a function of distance from the beam axis. An experiment was created to expand the laser beam and have it scanned with a narrow slit attached to a photo detector. By scanning the beam with the slit in known increments, a plot of intensity vs. distance can be made and compared to the theoretical result. A Gaussian fit describes well the collected data. From the results, it appears that the width of the distribution (for both red and green laser pointers) remains the same despite the distance from the detector. The measured distribution widths are (0.75 ± 0.05) mm and (0.38 ± 0.03) mm for the green and red laser pointers respectively.

33. Noncoalescence in Liquids of Similar Temperatures

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While waiting for our morning coffee to drip into our carafe, we noticed some drops behaving differently than all the others. The drops remained independent on the surface, not like an air bubble that groups together with others on the sides of the carafe. We made a movie to capture the events and later progressed to a high speed video to investigate the physics of these noncoalescing drops more closely. The drops formed, moved, and perished in a consistent pattern. We used Vernier's LoggerPro® software for video analysis and their LabPro® data logger for temperature readings. Along with some elegant physics this study nicely illustrates the prevalence of physics in everyday life. The study uses software and equipment available to most high schools (except, perhaps, the high speed camera).

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