Washington State University 2016

SUMMER UNDERGRADUATE RESEARCH SYMPOSIUM

9 a.m. to 1 p.m.
Tuesday, August 2

Smith CUE, 2nd Floor
Washington State University

Office of
Undergraduate
Education
Washington State University

Welcome to the WSU Summer 2016 Undergraduate Research Poster Symposium!

This summer the Office of Undergraduate Research at Washington State University has had the pleasure of hosting exceptional student researchers from around the world. We had multiple Research Experience for Undergraduates (REU) programs funded by the National Science Foundation (NSF), one program funded by the United States Department of Agriculture (USDA), and others supported by private grants and funding. Student participants in these programs represent a wide range of majors, and join us from schools ranging from small colleges that only offer undergraduate degrees to large Tier 1 research universities. More than 85 students from over 40 institutions are participating in this event; about one third of them are from WSU.

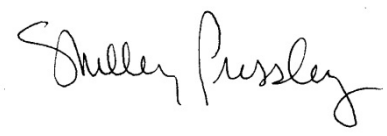
The wide range of research done by these students in various programs across campus fits the model of undergraduate research: the students take ownership of their projects, which are mentored, unique, and appropriate to the discipline in which they work. Their work is being disseminated at today's symposium. It is quite possible that peer-reviewed journal articles and presentations to national audiences will follow for some.

Below is a list of the program directors, and associated programs supporting students conducting research, who are sharing their work at the 2016 poster symposium:

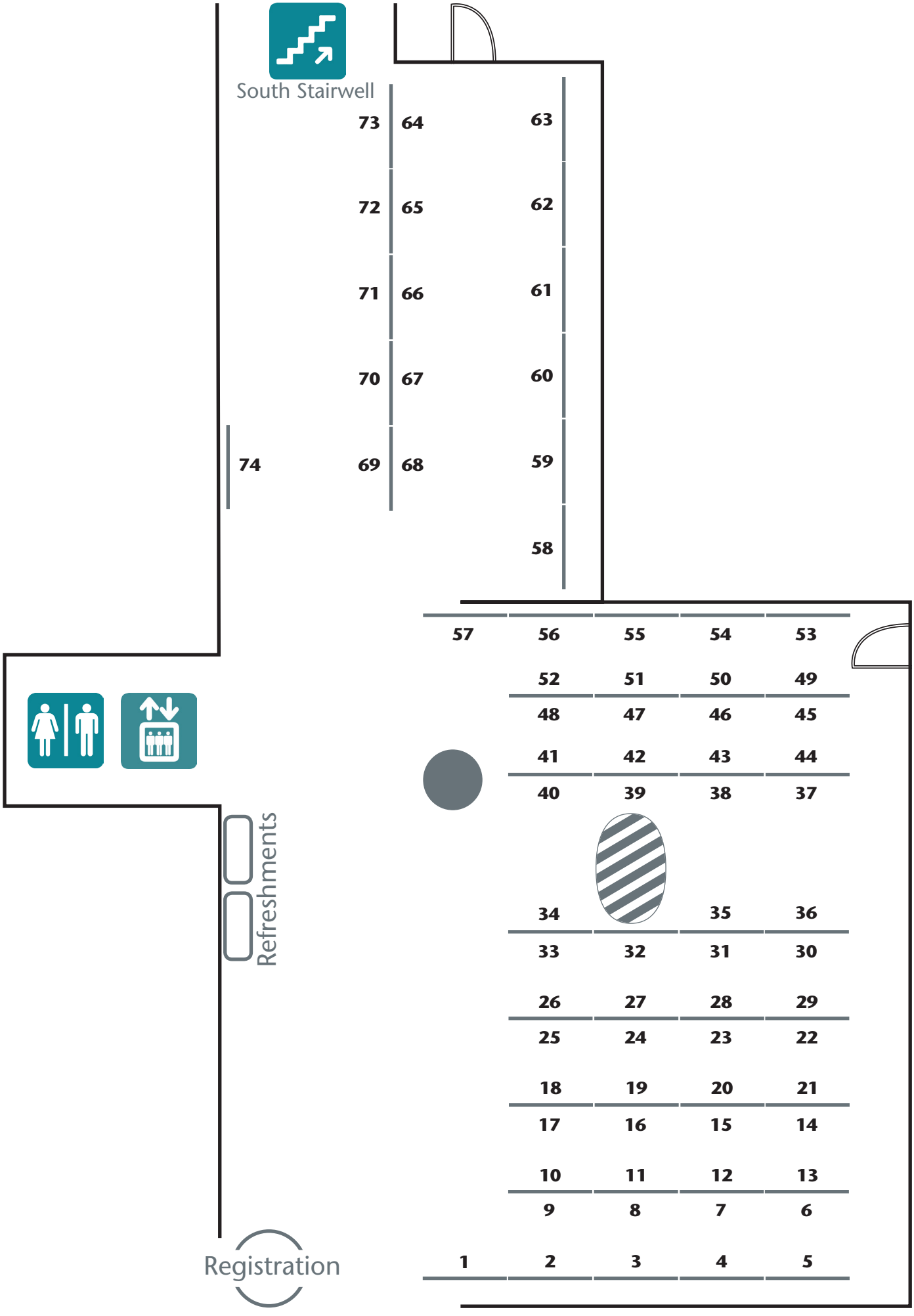
Larry Holder, Electrical Engineering and Computer Science REU
Partha Pande and **Behrooz Shirazi**, Electrical Engineering and Computer Science REU
Shelley Pressley and **Jennifer LeBeau**, Atmospheric Chemistry REU
Gretchen Rollwagen-Bollens, Landscape Ecology and Ecosystem Dynamics REU (WSU-V)
Amit Dhingra, Plant Genomics and Biotechnology
Diane Cook and **Maureen Schmitter-Edgecombe**, Gerontechnology
Samantha Gizerian, Biomedicine
Shelley Pressley, Northwest Advanced Renewables Alliance

Other faculty also work with and mentor undergraduate students in areas including mechanical and materials engineering, chemical engineering, biological systems engineering, electrical engineering and computer science, civil engineering, chemistry, and bioengineering. Their students will be presenting their work at the symposium as well.

The students' work, of course, would not be possible without faculty advisors supervising students and integrating them into their research groups. It's also made possible by all the staff, graduate students, and other researchers on campus who have fully embraced these students' efforts. I would also like to note that, in addition to the financial support of the NSF and USDA, the students and programs have had financial support from various departments (and their colleges), and the Office of Undergraduate Research. I hope you enjoy the poster symposium. This abstract book will be available on our website, UndergraduateResearch.wsu.edu.



Shelley Pressley, Ph.D.
Director, Undergraduate Research
Office of Undergraduate Education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Refreshments
Registration

Presenters by Group and Location

Group 1: Northwest Advanced Renewables Alliance – NARA (Summer Undergraduate Research Experience)		
#	Poster Title	Author
1	Comminution of Unmerchantable Forest Residuals to Determine Power and Energy Consumption as a Function of Moisture Content and Size Reduction Range	John Barth
2	Development of Epoxy Coating Technology for Lignosulfonate Hydrogel	Muhui Chen
3	The Value of Slash Trees and Snags in Forest Ecosystems	Jessica Curry
4	Characterization of Molecular Structure and Interlinkage Network for Seven Representative Biorefinery Lignin	William Daniels
5	Regional equations for streams in forested watersheds in the Pacific Northwest	Allie Davis
6	Biofuel Concept Learning Assessment of Middle School and Elementary School Youth through the Value of a Tree Lesson Plan	McKayla Drozd
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8	Lesson Plan: Life Cycle Assessment of NARA Jet Biofuel	Sarah Knue
9	Energy Literacy and Sustainability Topics in a High School Problem-Solving Competition	Sarah Pate
10	DES for the extraction of lignin from biomass and simulation using Aspen Plus	Thomas Potolicchio

11	Educating Youth on the Carbon Cycle Within Biofuel Production	Shalonda Robinson
12	Water-based Acrylic Polymer with Cellulose Nanocrystal for coating on the food packaging films	Guadalupe Salazar
13	Application development for kraft lignin and waste cooking oil-based epoxy asphalt	Emily Sun

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14	Role of the locus coeruleus in cocaine memory reconsolidation	Jade Donaldson
15	Investigating Neural Pathways affected by GPR40 Fatty Acid induced Activation and Mercaptoacetate induced Inhibition using c-Fos Brain Imaging	Pablo Martinez-Silva
16	Sleep and stress: Exploring how the HPA axis mediates stress-induced sleep disruption.	Keila S. Velazquez-Arcelay
17	Involvement of the endogenous cannabinoid system in the prefrontal cortex with respect to cognitive flexibility	Collin Warrick

Group 3: New-Generation Power-Efficient Computer Systems Design (REU in Electrical Engineering and Computer Science)		
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21	Evaluation of Network-on-Chip Architectures Using a Flit-Level Wormhole Switching Simulator	Danielle Forrest, Soyeun Jung and David Noel
22	Dynamic Power Optimization of VLSI Bus Interconnects Based on Skewing-Based Crosstalk Minimization	Mauricio Jimenez
23	A Filter Bank of high-Q bandpass filters to find Fourier Series Coefficients for TRDMA system	Jinyanzi Luo
24	Finite Difference Time Domain Simulation of Time-Reversal Division Multiple Access for Wireless Networks on Chip	Catherine Oseguera
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27	Changes in Carbon Dioxide Concentration and Flux Over a Large Southern Inland Water Body	Justin Bonds
28	Nitrous Oxide Emissions From Agricultural Sources Using the Nocturnal Storage Ratio Technique	Dylan Curtis
29	Methane and Carbon Dioxide Concentration Patterns over Washington State University's PACCAR Building	Brandon Daub
30	A quantification of VOC emissions from carpet in a residence with a high level of formaldehyde	Cari Gostic

31	An Evaluation of ClearSky2&3 for the RARE 2013 Field Burning Campaign	Tariq Hamzey
32	Analysis of a 2012 Ozone Episode in the Spokane - Coeur d'Alene Area	Eric M Lopato
33	Air Trajectory Analysis for Forecasting Future Air Quality	Allison Ronan
34	Comparison of Surface Energy Budget and Carbon Dioxide Flux between Urban and Agricultural Environments.	Nathan Sparks
35	Comparison of AIRS and MODIS precipitable water vapor retrievals with data from Arctic locations	Pyxie Star
36	Lewiston-Clarkston Valley Air Sampling Measurement Campaign	Jaime Torres
37	Measuring CO2 emissions as a Basis for Understanding Indoor Air Quality and Ventilation Rates	Mercedes Winfrey

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#	Poster Title	Author
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39	Evaluation of N. tabacum lines expressing Malus ALBINO3	Chelsea Crabb
40	Establishing in vitro resources for Vitis vinifera 'Pixie' transformation	Shirley Guzman
41	Effects of chemical compounds on germination of legume and grass cultivars	Brennan Hyden

42	Genetic Classification and Identification of old apple genotypes in the Kwina Estate – a move towards food sovereignty and security	Na'ta'ne Miles
43	Evaluation of Molecular Markers for Root Rot Resistance in Pea (Pisum sativum)	Corbin Schuster

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44	Development and Usability Testing of the Digital Memory Notebook for iOS	Eric Chen
45	The Development of a User-Centered Digital Memory Notebook	Brittany Cole
46	Aiding everyday activities with prompting technology: A qualitative analysis of dimensia participants' experiences	Kelsey Dammeyer and Brooke Robinson
47	The Night Out Task: Everyday Functioning Assessment of Older Adults and Younger Adults	Alexis Fuller
48	Speech to Text for Monitoring Nutritional Health	Joshua Kolasch
49	The WORRDS Project: Visually Providing Users with Readable and Meaningful Data from Smart Homes	Aaron Kwan and Timothy McAleer
50	Using Wearable Sensors to Detect Changes in Physical Activity	Alyssa La Fleur
51	Activity-Aware Medication Adherence	Amir Hossein Rezamand
52	Using Amazon Echo as a Framework to Communicate Patient Results from CASAS Smart Homes	James Riggleman

53	Night Out Task	Wesley Smith

Group 7: Smart Environments (REU in Electrical Engineering and Computer Science)		
#	Poster Title	Author
54	Examining Perception of Unmanned Aerial Systems	Kathryn Kresnye
55	Top-k Event Discovery for Graph Streams	Shayan Monadjemi
56	Switching Algorithm for the Phasor Measurement Unit (PMU)	Linh Nguyen
57	3D UWB Localization Based Infant Pain Assessment System in Incubators Using Dynamic Averaging Algorithm and Ranging	Biniyam Obsu
58	GraphZip: Dictionary-based Compression for Graph Mining	Charles Packer
59	Comparing artificial intelligence systems using visual-only input through ViZDoom	Christopher Pereyda
60	Randomized Local Search for Structured Prediction	Vanessa Putnam
61	Graphical User Interface for RepeatAnalyzer	Jonathan Squibb
62	Activity Recognition and User Identification Using a Wearable Stretch Sensor	Ryan Torelli
63	Renaming Automatically Generated Java Code	Timothy Vierow

Group 8: Mechanical and Materials Engineering, Chemical Engineering, Biological Systems Engineering, Electrical Engineering and Computer Science, Civil Engineering, Chemistry, and Bioengineering		
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65	Investigation of the composition of aqueous phase thermochemical product using various methods of analytical chemistry.	Kristen Ford
66	PERKS: Power Electronics Refined Learning via affordable kit and Software tutor	Jacob Greig-Prine
67	New Evidence for the Site-Pairing Preference of Framework Aluminum in ZSM-5, from its Reaction with Ga(CH₃)₃	Kyle Groden
68	Importance of Plan Curvature in Watershed Models	Jared Ribail
69	Construction and Testing of a Modular Ion Mobility Spectrometry Cell with Faraday Plate or RIIN Detection	Carolyn Saba
70	The Effect of Starvation on Bacterial Survivability in Sand and Evolution of Biofilms	Chia-Ling Kang
71	Escherichia coli Strains' growth and biofilm formation with respect to their antibiotics' resistance	Hassan Zbib
72	Observation of stochastic mechanical behavior in polycrystalline Nb during nanoindentation	Saul Moran
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Group 9: Landscape Ecology and Ecosystem Dynamics of the Columbia River Basin: Integrating Aquatic and Terrestrial Perspectives – (REU Site at WSU Vancouver)		
#	Poster Title	Author
74	"Landscape Ecology and Ecosystem Dynamics of the Columbia River Basin: Integrating Aquatic and Terrestrial Perspectives" REU Site at WSU Vancouver	Gretchen Rollwagen-Bollens (Student Researchers: Michelle Devlaeminck Aramee Diethelm Kelsey Fenn Francesca Frattaroli Madeline Kelsch Katarina Kubiniec Rae Kuhlman Jasmine Nguyen)

Group 1: Northwest Advanced Renewables Alliance – NARA (Summer Undergraduate Research Experience)

1	**Comminution of Unmerchantable Forest Residuals to Determine Power and Energy Consumption as a Function of Moisture Content and Size Reduction Range**	1

Undergraduate Researcher: John Barth

Coauthors: Dr. Jinwu Wang, Dr. Michael Wolcott, Vincent McIntyre, Kelley Welsch

Home Institution, Major, Class Standing: Washington State University, Economics, Senior

Abstract:

Research into biofuels is creating new sources of sustainable energy. In the Pacific Northwest unmerchantable forest residuals-a byproduct of logging-is being looked into as a potential source of biojet fuel. However, the process of breaking down this byproduct is extremely energy intensive. Thus, my research objective is to create an equation to determine energy consumed based on the moisture content and size reduction range of the woody biomass and to identify the optimal conditions for the material size reduction. To reach this objective I am measuring the energy consumed by running the material through a small scale industrial hammer mill using 4 different levels of moisture content as well as multiple screen sizes at each moisture content to get varying particle size reductions. A G-series elite conditioning chamber is used to condition the wood to each moisture content, and a rotap testing sieve shaker is used to determine the average particle size after each size reduction. I have currently completed all of the different particle size transfers for each of the varying moisture contents. Going forward, sieve analysis will need to be finished to determine the average particle size for each of the varying screen sizes. With the results taken from measuring the energy consumed, as well as the average particle size, a constant for each moisture content and particle size reduction will be created using the Rittinger's comminution equation. The constant will vary with the four different moisture content levels investigated in this project and the relationship between them will be correlated by an empirical equation. The finished equation will show that the amount of energy consumed is a function of the moisture content and the size reduction and would be able to predict the most optimal conditions for breaking down the forest residuals. This will aid in the production of future biojet fuels.

2	**Development of Epoxy Coating Technology for Lignosulfonate Hydrogel**	2

Undergraduate Researcher: Muhui Chen

Coauthors: Hui Xu, Junna Xin, Jinwen Zhang

Home Institution, Major, Class Standing: Bryn Mawr College, Chemistry, Senior

Abstract:

Rising environmental concerns and the depletion of natural resources has directed the public's attention to polymer-based biodegradable and renewable materials. Lignin is the second most abundant natural polymer. Lignin is vastly applied as a byproduct of industries involved in retrieving the polysaccharide components of plants. The significant features of lignin include high abundance, low mass, antioxidant and antimicrobial properties; these make lignin an ideal resource in the novel study of polymer composite materials.

Based on environmental and economic benefits, the prime interest of lignin application is the development of useful derivative materials. Sodium lignosulfonate, a commercial product but belongs to the category of lignin products, is used to synthesize Lignosulfonate Amine (LA), which contains a large number of hydrophilic groups and exhibits high reactivity in making hydrogel. Lignosulfonate amines were prepared from sodium lignosulfonate, formaldehyde, and diethylenetriamine via a Mannich reaction.

Hydrogel has properties of high water absorption capacity, long service life, and environmental tolerance. Hydrogel is a cross-linked polymeric material which exhibits a similar flexibility level to natural tissue due to its water-swollen characteristic, but will not dissolve in water. Lignin based hydrogel was prepared by polymerization of lignosulfonate amine in the presence of Poly(ethylene glycol) diglycidyl ether (PEGDGE) as the cross linker.

This research is intended to maximum the urea releasing ability of lignin based hydrogel via coating method. Hydrogel was coated by an epoxy resin from chitosan cured with a commercial epoxy monomer. The effect of chitosan on the persistence of urea for agricultural use was investigated. Hydrogels with epoxy coating preserved urea releasing rate to provide nutrients as a relatively long term fertilizer. A number of publications dealing with lignin and hydrogel products were examined, but only few resources discuss the potential efficacy and development of controlling release by epoxy coating technology for hydrogel.

3	The Value of Slash Trees and Snags in Forest Ecosystems	3

Undergraduate Researcher: Jessica Curry

Coauthors: Aaron Boyles, Katie Mosman, Leslie Dorsey

Home Institution, Major, Class Standing: University of Idaho, Natural Resources Conservation-Science Emphasis, Senior

Abstract:

Abstract: Management practices and research are necessary for the existence of stable forest ecosystems. These methods are especially important for timber harvesting. Northwest Advanced Renewables Alliance (NARA) uses woody biomass from slash trees to formulate jet fuel through a series of chemical processes. NARA has been working with timber agencies to acquire the biomass they need for fuel production. In the past, slash from timber harvest was burned. For this to be a sustainable practice, NARA has conducted research in many sample forests to study how the removal of slash (woody biomass) affects the forest ecosystem. With this information, NARA can actively manage the problems that may occur due to the removal of slash. This lesson addresses the role and value of slash trees and snag trees in forest ecosystems.

I pilot tested this lesson on a group of 20 students grades 6th through 9th. The objective for the lesson is to educate students about forest ecosystems and their components. The lesson begins with a description of forests that sets the stage for explaining the value of a snag (dead tree) and a slash tree in forest ecosystems. The students are then divided into groups and each group receives a folder containing one of the following five scenarios that could occur in a forest ecosystem 1) Slash pile remains in the forest 2) Slash pile is removed from the forest 3) Slash pile is burned 4) A forest fire occurs 5) A snag forest. Students then determine how each scenario affects different components of the forest ecosystem. We discuss each group's results and then compare and contrast them. This lesson allows the students to understand the value of slash tress and snags through their own brainstorming and the class discussion.

4	**Characterization of Molecular Structure and Interlinkage Network for Seven Representative Biorefinery Lignin**	4

Undergraduate Researcher: William Daniels

Coauthors: Ruoshui Ma

Home Institution, Major, Class Standing: Colorado School of Mines, Chemical Engineering, Sophomore

Abstract:

Along with cellulose and hemicellulose, lignin is one of the three major components of plant biomass, representing up to 40% of the dry weight. Because polysaccharides have been the primary focus for industrial applications, there is already a large amount of lignin being produced annually as a waste product. Therefore, lignin has begun to attract much attention as a potential renewable resource for bio-based materials, fuels, and chemicals. Lignin consists of three major subunits: p-hydroxyphenyl (H), guaiacyl (G), and syringyl (S), and there are a number of lignin sources available, including: wood pulp, corn stover, and wheat straw. However, many factors such as mother biomass source and extraction method result in different physical and chemical lignin properties. In this study, we provide an assembled analysis of seven representative biorefinery lignin. Structural information was obtained using thioacidolysis and nitrobenzene oxidation, side chain functional groups were estimated using Fourier transform infrared spectroscopy (FTIR), and interlinkage structures are analyzed based on quantitative 13C NMR analysis and HSQC NMR. The results from both thioacidolysis and nitrobenzene oxidation are very similar, showing that the percentage of G subunits can vary from 85% to 99%. Analyzing the peaks in the absorbance spectrum from FTIR will show the presence of various functional groups on lignin side chains. Finally, HSQC NMR spectra will show the abundance of both ether linkages and carbon-carbon linkages.

5	**Regional equations for streams in forested watersheds in the Pacific Northwest**	5

Undergraduate Researcher: Allie Davis

Coauthors: Kaleb Madsen, John Petrie

Home Institution, Major, Class Standing: Henderson State University, Biochemistry, Senior

Abstract:

The USDA-funded Northwest Advanced Renewables Alliance (NARA) project seeks to reach and maintain economic, environmental, and social sustainability in the production of biojet fuels. Elevated levels of suspended sediment in bodies of water from logging and tilling are extremely detrimental to aquatic environments. In the Pacific Northwest, salmonid and macroinvertebrate populations are steeply declining because of sharply degrading water quality and changing physical characteristics of rivers. This study takes water and stream channel characteristics from several hundred sites in the Pacific Northwest in order to establish trends in the form of regional equations that can be generally applied to all channels in the same geomorphic province. The implementation of regional equations in the field of hydrology is key to predicting changes in water parameters as a result of natural and anthropogenic effects. Not only can regional equations roughly estimate certain physical characteristics (width, depth, and slope) of streams from discharge or drainage area, but they can also predict suspended sediment loads with relative accuracy. This is powerful to the NARA project as it can help in predicting the effects of biojet fuel production on the parameters of the channel and in turn the aquatic life residing in it. General regional equations have been developed and determined to be statistically significant to the Pacific Northwest area and more specific physiographic province equations have also been produced in an effort to determine the significance of location and climate upon a watershed's physical characteristics.

6	**Biofuel Concept Learning Assessment of Middle School and Elementary School Youth through the Value of a Tree Lesson Plan**	6

Undergraduate Researcher: McKayla Drozd

Coauthors: Peter Schumann, R. Justin Hougham, Marc Nutter

Home Institution, Major, Class Standing: University of Wisconsin Stevens Point, Biology, Senior

Abstract:

The Northwest Advanced Renewables Alliance (NARA) is an organization that aims to create a sustainable aviation biofuels production industry in the Northwest United States. One of NARA's goals is to educate the next generation of energy leaders to understand the possibility of using the top 23% of trees as biomass for jet fuel. This project focuses around the effectiveness of using the Value of a Tree lesson plan to teach youth about the importance of energy sources. The activity was facilitated through a portion of presented material, followed by an outdoor hands-on activity. The students were first presented the material at Upham Woods, Wisconsin Dells. A follow-up lesson was conducted at their school with hope that they will be able to connect these important ideas and skills to multiple places. Before the lesson, students took an assessment and then following the lesson the same assessment was taken again. The pre- and post-knowledge based assessment for middle school and elementary school youth were analyzed using a paired t-test, item discrimination, and item difficulty. This project was in effect from January 1st to December 31st 2016. So far approximately 362 youth, grades 3-8, and 82 formal teachers and educational providers have been engaged in VOAT material. There was no statistically significant evidence to support the conclusion that the knowledge was gained after receiving the Value of a Tree lesson. However, based on the results it was found that a large majority of the elementary school questions are usually considered unacceptable. Future modifications of the lesson plan and the assessment are necessary if knowledge gain is to be more apparent. Possible areas of improvement include: making it more appropriate to our younger audiences, making the lesson components more hands-on and interactive, and editing the survey questions to be more acceptable for younger ages.

7	Types of Energy with Biofuels Applications	7

Undergraduate Researcher: Abigail Flowers

Coauthors:

Home Institution, Major, Class Standing: Kalamazoo College, Physics, Junior

Abstract:

Energy is a fundamental concept in the Northwest Advanced Renewables Alliance (NARA) process. For students to obtain a deeper understanding of biofuels, we must explain both energy and the law of conservation of energy. Energy is the ability to do work. All energy falls into two categories; potential energy and kinetic energy. Potential energy is stored energy while kinetic energy is energy associated with movement. Potential energy is divided into subcategories such as chemical energy and gravitational energy. Kinetic energy is divided into categories such as thermal energy, relational energy, and rotational energy. The law of conservation of energy states that energy cannot be created or destroyed.

This lesson first teaches students about kinetic, potential, chemical, and thermal energy. Students go through the NARA process of creating biofuel and identify the various types of energy in each step. Students are then told about the law of conservation of energy. Next they are asked whether or not the NARA process is a good example of a system that follows the law of conservation of energy. Students are then asked to define what an efficient process is in terms of conservation of energy. Students are then left to think about whether or not the NARA process is actually energy efficient. This lesson will be tested with 6-9th graders at the McCall Outdoor Science School.

8	Lesson Plan: Life Cycle Assessment of NARA Jet Biofuel	8

Undergraduate Researcher: Sarah Knue

Coauthors: Mike Frohely, Karla Eitel

Home Institution, Major, Class Standing: Boise State University, Civil Engineering, Sophomore

Abstract:

Life cycle assessments are an effective means for analyzing the inputs, outputs, and waste associated with a product's creation, usage, and disposal. The Northwest Advanced Renewables Alliance (NARA) has been utilizing this assessment tool to determine the environmental health impacts of producing jet biofuel from woody biomass when compared to conventional methods of procuring petroleum.

This stand-alone lesson seeks to educate students in grades 6 through 8 about the pros and cons of biofuel and the process associated with its creation. Students will develop their own life cycle assessment of the NARA jet biofuel development process using provided information and deductive reasoning, considering the environmental, economic, and social implications of this process. Students will then compare this life cycle to that of jet fuel produced from non-renewable sources. Students will also assess their own wasteful practices and touch briefly on the human carbon footprint in order to provide context for the importance of reducing waste. Students will then be evaluated at the end of the lesson based on their ability to provide an opinion about the merits or detriments of either jet fuel source. This lesson was developed and refined based on student and mentor feedback following the implementation of the lesson.

9	**Energy Literacy and Sustainability Topics in a High School Problem-Solving Competition**	9

Undergraduate Researcher: Sarah Pate

Coauthors: Quinn Langfitt, Trace Sendele, Liv Haselbach

Home Institution, Major, Class Standing: University of Alabama, Chemical Engineering & Applied Math, Junior

Abstract:

The Alaska Airlines Imagine Tomorrow High School Problem-Solving Competition is an energy and sustainability competition held at Washington State University where students compete in the following challenges: Food, Energy & Water, the Boeing Aerospace Challenge, the NARA Biofuels Challenge, and the McKinstry Built Environment Challenge. The different approaches students take on in the challenges are Technology, Design, and Behavior. The goal was to determine the students' energy literacy for posters that are energy centric, as well as other topics that are most common for non-energy centric posters. Some posters were focused on energy topics, while others were focused on additional sustainability topics. All of the posters were evaluated using a rubric for energy literacy correlated to the US Department of Energy's energy literacy principles. The energy centric poster scores were correlated to various variables about the competing teams. The topics and content of the non-energy centric posters were also evaluated through key words and phrases present in those posters. The energy literacy rubric results compared scores through the challenge and approach students took, their gender, grade, activity type, number of years the advisor has attended, and other similar variables. The key words and phrases from the non-energy centric posters were presented in a word cloud to demonstrate their frequency of use. Preliminary results show that pollution, recycling, and water are popular topics for the non-energy centric posters.

10	DES for the extraction of lignin from biomass and simulation using Aspen Plus	10

Undergraduate Researcher: Thomas Potolicchio

Coauthors:

Home Institution, Major, Class Standing: WSU Tri-Cities, Mechanical Engineering, Junior

Abstract:

The three primary components of plant cells are cellulose, hemicellulose and lignin. Cellulose is the most desirable component and it has many uses from paper to biofuel. Currently lignin is primarily seen as a byproduct of pulp mills and biomass refineries. Lignin content percentages vary depending on which type of plant material is used. Refining biomass without using the lignin leaves a portion unused. In wood biomass that can be a significant amount, up to 40%.

The benefit of biofuels is that they are renewable. Paper and pulp mills plant more trees than they cut. As much of the biomass as possible needs to be used for production to see the most profit. Uses for lignin as a value added material are being researched.

Lignin can be extracted by several methods, but the focus of this research is using deep eutectic solvents. DES is considered to be a “green” solvent and therefore better for the environment than using highly acidic or basic solvents for example. Use of other chemicals can produce negative side effects so finding a biodegradable, non-reactive and safe solvent is a priority in the biofuel industry.

In this project DES is formed by mixing two salts, choline chloride and lactic acid, which form a liquid when mixed. The biomass and DES are mixed and heated. The temperatures used experimentally have been relatively low. The mixture was observed for varying periods of time and then filtered to separate the lignin, DES and the cellulose.

The results in the lab have been promising. Large scale production has not been achieved at this time. I have been working with Aspen Plus to get a simulation of the experiment. Once the simulation is complete for the small scale, it can be scaled up.

11	Educating Youth on the Carbon Cycle Within Biofuel Production	11

Undergraduate Researcher: Shalonda Robinson

Coauthors: Karla Eitel, Leslie Dorsey, Aaron Boyles

Home Institution, Major, Class Standing: California State University Los Angeles, Mathematics, Senior

Abstract:

The Carbon Cycle is the process by which carbon is used, released, and stored. Using common crops rather than fossil fuels, the carbon cycle helps create renewable fuels that can be up to one hundred times healthier for the environment. Our youth is our future, and if we want a healthy future environment, we need to teach them how to achieve it. From this lesson, the students will learn about the carbon cycle by understanding the process and how carbon is effectively and efficiently turned into biofuel.

In the lesson, the students will do an outdoor demonstration symbolizing how the carbon cycle can produce fuel to make a jet fly. Students will reinforce this understanding by creating bottle rockets. Each student has one bottle with vinegar inside. The student then puts a leaf or a piece of grass in the bottle. The students are then given a balloon and fill it with baking soda that symbolizes a plane or jet. Once each student places their balloon onto the bottle the baking soda will fall into the vinegar causing a reaction and carbon dioxide to form. Each student then holds the rim of the bottle as the balloon will begin to expand. The lesson is designed to be taught to students from the grade levels of 6th-12th. Each student will take a survey that will show if the students understood and learned the following concepts: what the carbon cycle is, the importance of the carbon cycle, how the carbon cycle can help the world, the carbon cycle process, what biofuel is, examples of biofuel, and how carbon dioxide can be created.

12	**Water-based Acrylic Polymer with Cellulose Nanocrystal for coating on the food packaging films**	12

Undergraduate Researcher: Guadalupe Salazar

Coauthors: Lanxing Du, Jinwu Wang, Michael Wolcott

Home Institution, Major, Class Standing: University of Michigan, Chemical Engineering, Senior

Abstract:

Production of biofuels from woody biomass yields a significant amount of cellulose as a byproduct which is biodegradable, non-toxic, and has strong gas barrier properties. The goal of the work is to reduce the waste in biofuel production by developing an application for the cellulose in food packaging coatings by production of a Water-based Acrylic Polymer using Cellulose Nanoparticles. This was done by using a TEMPO-mediated oxidation on the surface of the cellulose to improve its solubility in water and the polymers capability to be coated based on the structure of the cellulose.

In order to develop a coating, several cellulose varieties, including Cellulose Nanocrystals, Nanofibers, and Microcrystals, were used at different weight percentages in the Acrylic Polymer emulsion. Determining the feasibility of the coatings for food packaging applications was done by testing the thermal stability, tensile strength, viscosity, emulsion stability, and gas barrier properties of the Acrylic Polymer-Cellulose emulsion coated onto Biaxially Oriented Polypropylene Films. An analysis of the different emulsions provided mixed results on the effectiveness and applicability of the polymers for food coatings due to an inverse relationship of viscosity and the capability of cellulose to emulsify in solution. As the weight percentage of cellulose increased so did the viscosity.

There is promising evidence towards the future use of an Acrylic Polymer-Cellulose coating as a gas barrier in food packaging applications but further investigation is needed into finding a cellulose size that has a chain length that can provide the necessary network but is capable of being fully dissolved into the emulsion.

13	**Application development for kraft lignin and waste cooking oil-based epoxy asphalt**	13

Undergraduate Researcher: Emily Sun

Coauthors: Ran Li, Junna Xin, Jinwen Zhang

Home Institution, Major, Class Standing: University of California Berkeley, Chemical Engineering, Junior

Abstract:

In this project, epoxy resins made from waste cooking oil (WCO)-based epoxy and a Kraft lignin-based curing agent (KL-COOH) were used to modify asphalt. Compared to commercial materials currently in use, biobased materials made from renewable feedstocks are advantageous from an environmental standpoint. The use of lignin, which is a waste product of common biofuel synthesis processes, also offers economic advantages.

Tri-acid was synthesized from the fatty acid components of WCO, and then glycidylized by reaction with epichlorohydrin to form the tri-epoxy monomer. The epoxy curing agent was prepared by carboxylation of Kraft lignin. With nadic methyl anhydride (NMA) as a co-curing agent, epoxy resin samples were cured using several different molar ratios of WCO-epoxy and KL-COOH, using 2-ethyl-4-methylimidazole as a catalyst. Curing behavior was studied using differential scanning calorimetry (DSC), and epoxy resin thermal properties were analyzed using dynamic mechanical analysis (DMA) and thermogravimetric analysis (TGA). The rheological properties of epoxy-modified asphalts were evaluated using a parallel plate rheometer. The commercial and biobased epoxy materials were compared in terms of both curing behavior and effects on epoxy asphalt performance.

Results are expected to indicate improvement in asphalt performance with modification by epoxy resin, especially at high temperatures. The curing behavior and mechanical properties of biobased and commercial epoxy resins are expected to be comparable. Further research may expand upon the viability of WCO- and lignin-based materials as substitutes for commercial materials in epoxy asphalt applications.

Group 2: College of Veterinary Medicine (Summer Undergraduate Research Experience)

14	Role of the locus coeruleus in cocaine memory reconsolidation	14

Undergraduate Researcher: Jade Donaldson

Coauthors: Rita Fuchs Lokensgard, Jessica Higginbotham

Home Institution, Major, Class Standing: Bates College, Neuroscience and Anthropology, Junior

Abstract:

When drug-context associated memories are recalled, they become sensitive to change. In this labile state, associative memories must be reconsolidated in order to be maintained as long-term memories. Previous studies have shown that bidirectional interactions between the basolateral amygdala (BLA) and the dorsal hippocampus (DH) are necessary for reconsolidation of context-response-drug associative memories. Furthermore, beta-adrenergic receptor simulation of norepinephrine (NE) in the BLA is required for Pavlovian memory reconsolidation. However, contributions of NE or beta-adrenergic receptors to memory reconsolidation have not been examined using an instrumental model. To this end, rats were trained to press a lever for cocaine infusions in a distinct environmental context, followed by extinction training in a different context. The rats were then briefly re-exposed to the drug-associated context to destabilize cocaine memories. Immediately after this session, propranolol, a beta-adrenergic antagonist, was infused into the BLA. We hypothesized that propranolol administration following memory reactivation would disrupt cocaine memory reconsolidation and thus decrease drug context induced reinstatement of drug-seeking behavior. The main source of NE to the BLA is the locus coeruleus (LC). The LC is connected to both the BLA and the DH and thus may relay information between these brain regions. In order to identify the subregions of the BLA and the DH that are innervated by the LC, we injected herpes simplex virus 129, an anterograde viral tracer tagged with green fluorescent protein, into the LC. After allowing the polysynaptic tracer to spread for a period of 48-hours, immunohistochemistry was used to visualize putative polysynaptic cell bodies within the BLA and DH and to phenotype these neurons. Together, the findings of this investigation can provide preliminary data for future experiments involving the manipulation of specific projections between the LC and the BLA or DH in an effort to further map the memory reconsolidation circuitry.

15	**Investigating Neural Pathways affected by GPR40 Fatty Acid induced Activation and Mercaptoacetate induced Inhibition using c-Fos Brain Imaging**	15

Undergraduate Researcher: Pablo Martinez-Silva

Coauthors: Ai-Jun Li, Sue Ritter

Home Institution, Major, Class Standing: University of Notre Dame, Neuroscience and Behavior, Junior

Abstract:

G-protein coupled receptor 40 (GPR40) is a membrane receptor for long and medium chain fatty acids (FA). GPR40 receptors are located on taste cells, on enteroendocrine cells in the intestine that secrete satiety hormones in response to fat ingestion, and are important for control of insulin secretion. Thus, they are important for control of food intake, obesity and as a therapeutic target for treatment of diabetes. GPR40 receptor activation signals the brain by direct actions on the vagus nerve and indirectly via released vagally-dependent satiety peptides. Mercaptoacetate (MA) is an orexigenic drug shown recently to reduce FA-induced release of enteroendocrine satiety peptides and insulin secretion by blocking GPR40 receptors. MA's stimulatory effects on feeding have also been demonstrated to be vagally-mediated. However, very little is known about the neural pathways altered by GPR40-induced vagal stimulation or by MA's inhibition of those receptors. Therefore, we used c-Fos, a protein marker of neuronal activation, to examine that question. Our hypothesis is that MA should block effects of FA on central sites. First, we will examine the separate effects of MA and fatty acids on c-Fos expression in hindbrain and hypothalamic feeding sites. We predict that these two treatments will have opposite effects on these brain sites. Next, we will administer fatty acids and MA together to see if MA antagonizes effects of fatty acids at these sites. c-Fos and markers for two candidate neurotransmitters, DBH MCH, will be fluorescently labeled using immunohistochemistry. Brains will be imaged and the overlap between fluorescent markers will be analyzed to determine whether either neurotransmitter is involved in responses that might account for FA-induced satiety or MA's antagonism of that effect. Finally, if time permits, we will determine whether FA and MA effects on central neural activation are altered by deletion of the GPR40 gene in mice.

16	**Sleep and stress: Exploring how the HPA axis mediates stress-induced sleep disruption.**	16

Undergraduate Researcher: Keila S. Velazquez-Arcelay

Coauthors: Scott A. Kinlein, Ilia N. Karatsoreos

Home Institution, Major, Class Standing: Universidad del Este Carolina, PR, Biotechnology, Senior

Abstract:

Biological responses to stress are crucial for the survival of organisms. The hypothalamic-pituitary-adrenal (HPA) axis is an important system responsible for the secretion of stress hormones—mainly cortisol in humans and corticosterone (CORT) in rodents—that help the body prepare to face a challenge. While normal acute stress responses are a necessary response to enhance survival, but disrupted acute responses and chronic stress have been attributed to detrimental effects to the body and impairment in response to stressors. Stress affects many physiological and behavioral variables, and previous studies demonstrated that sleep is disrupted after a stressful event. Here we study the effects of a chronically disrupted HPA axis on sleep. Our hypothesis is that disrupting normal HPA axis function will lead to changes in sleep following stress, but not affect normal sleep patterns. In our experiments, we administered a low dose of corticosterone (25ul/ml) or vehicle (1% EtOH) to adult male C56Bl6 mice in their drinking water for 4wks. Body weights were also measured each week. We then measured baseline sleep effects, followed by the changes in sleep in response to a forced swim stressor (FST). Sleep is measured using a novel technology that makes use of extremely sensitive piezoelectric plates that can detect changes in sleep by changes in breathing patterns. Use of the PiezoSleep technology instead of the traditional EEG electrodes implantations avoids invasive procedures such as surgery. Our findings will help clarify how stress affects sleep, and if the effects of stress on sleep require the normal function of the HPA axis. In addition, our studies will allow us to determine if disrupting the HPA axis is associated with changes in basal sleep patterns, which would help explain the links between stress resilience and sleep.

17	**Involvement of the endogenous cannabinoid system in the prefrontal cortex with respect to cognitive flexibility**	17

Undergraduate Researcher: Collin Warrick

Coauthors: Ryan McLaughlin

Home Institution, Major, Class Standing: Washington State University, Neuroscience/Biochemistry, Junior

Abstract:

The prefrontal cortex (PFC) is the center for executive functioning, overseeing cognitive strategies according to changing environments. The endogenous cannabinoid (ECB) system is expressed throughout the PFC and contributes to numerous PFC-mediated behaviors. However, the extent to which ECB signaling in the PFC influences cognitive flexibility has yet to be evaluated. Our study investigates whether pharmacological blockades of ECB signaling within the medial PFC (mPFC) alter cognitive flexibility in strategy shifting tasks. Rats will be implanted with bilateral cannulae aimed at the mPFC and trained to press levers in operant chambers for rewards. During the subsequent visual cue discrimination learning, lights will be illuminated above either lever and rats will be required to press the lever associated with the cue. To determine whether ECB signaling in the mPFC is involved in acquiring visual cue discrimination, separate groups of rats will receive microinfusions of CB1 receptor antagonist, rimonabant (0.3μg/0.2μL/side), or an equivalent volume of vehicle before testing. Rats that meet testing criterion will move on to strategy shifting, whereby they will be required to disregard the previously learned strategy (i.e., follow the cue) in favor of an egocentric spatial learning strategy (i.e., always press the left lever). Rats will again receive microinfusions prior to testing, and the number of trials to criterion and number of errors will be tabulated. We hypothesize that CB1 receptor inactivation will facilitate strategy shifting thereby reducing the number of trials to reach criterion and number of perseverative errors made, but will not significantly influence visual cue discrimination learning. If our hypotheses are confirmed, this will be the first study to show involvement of ECB signaling in the PFC within the domain of cognitive flexibility. Moreover, the results of this study could be leveraged to identify therapeutic targets for improving cognitive flexibility in clinical populations.

Group 3: New-Generation Power-Efficient Computer Systems Design (REU in Electrical Engineering and Computer Science)

18	**Power Management Circuit for SoC with Hybrid Switched Inductor and Switched Capacitor Voltage Regulator**	18

Undergraduate Researcher: Michael Berhane and Youssef Elasser

Coauthors: Zhiyuan Zhou

Home Institution, Major, Class Standing: University of Maryland College Park, Computer Engineering, Sophomore

Abstract:

A fully integrated power management system of switched-inductor voltage regulator (SIVR) and switched-capacitor voltage regulator (SCVR) is presented in a 180 nm CMOS. From an input voltage of 2.5 V, the SIVR will produce an output voltage of 1.3 V, which is then fed into the SCVR with a fixed conversion ratio of 3:2, providing an output voltage of 0.87 V. Using CMOS to implement the SIVR allows for higher efficiency and minimal off-chip components. Integrated capacitors manage to achieve low series resistance and high capacitance density, as well as allowing implementation of DC/DC converters in existing CMOS processes without adding extra steps in fabrication. Efficiency of these integrated capacitors is able to be maximized without the need to sacrifice space on the CMOS. The 3:2 SCVR, using multiphase interleaving, achieves conversion efficiency measured around 80% with the use of non-ideal components while supporting a maximum load current density of 0.9 amperes per square millimeter and a power density of 0.7 milliwatts per square millimeter. By operating the system in continuous conduction mode, keeping the current through the inductor of the buck converter positive at all time, power is always delivered to the load, improving efficiency. Increasing the power density exhibits a tradeoff between conversion efficiency of SCVR, thus highlighting the importance of finding an equilibrium point of high efficiency as well as high power density.

19	Analysis of Monolithic 3D IC Layouts	19

Undergraduate Researcher: Bardia Borhani

Coauthors: Dae Hyun Kim, Sheng-En Lin

Home Institution, Major, Class Standing: University of Washington Bothell, Computer Science, Junior

Abstract:

Three-dimensional (3-D) integration stacks multiple silicon layers and connects devices in different layers through inter-layer vias, thereby providing numerous benefits such as wire length reduction, performance improvement, and power saving. Inter-layer vias are fabricated in device layers, so they occupy non-negligible silicon area and have non-negligible parasitic resistance and capacitance. Thus, researchers have been trying to reduce the size of the inter-layer vias. For instance, the diameter of through-silicon vias (TSVs) has been reduced from 20um to less than 5um. However, the typical 3-D stacking technology has difficulties in reducing the TSV size further because the die thickness also reduces when the TSV size goes down and stacking and handling thin dies are very difficult. Monolithic 3-D integration overcomes the drawback that TSV-based 3-D integration has by fabricating multiple silicon layers sequentially in a single fabrication process. Thus, monolithic inter-layer vias (MIVs) used as inter-layer vias in monolithic 3-D ICs can be made extremely small. As a result, monolithic 3-D integration enables the most fine-grained integration of transistors.

An efficient design methodology developed to build multi-tier gate-level monolithic 3-D integrated circuits (ICs) uses 2D commercial software and linear downscaling to find optimal instance locations. Ideally, the total wire length of a k-tier, where k represents the number of tiers, monolithic 3-D design built by this methodology is w/s where w is the total wire length of its 2-D version and s is the square root of k. The actual wire length of the k-tier 3-D design, however, is longer than the ideal wire length due to the non-optimality inherent in the design methodology and the characteristics of each benchmark circuit. In this research, we develop an analysis methodology based on graph analysis to quantify the non-optimality due to the characteristics of digital VLSI netlists.

20	Circuit & System Design Using the COTS Approach	20

Undergraduate Researcher: Rodney Daniely

Coauthors: Subhanshu Gupta, Scott Hanson

Home Institution, Major, Class Standing: Jackson State University, Electrical Engineering, Senior

Abstract:

During this REU program, Rodney will focus on learning algorithmic techniques for machine-learning algorithms and neural network interfaces on a microcontroller. He will utilize the TI CC2650 launch pad development board with integrated 2.4GHz radio to develop a working prototype. He will develop energy-efficient machine-learning algorithms to implement in this prototype. Dynamic voltage scaling (DVFS) is a power management technique in computer architecture, where the voltage is used as a controlling component and is increased or decreased, depending upon power demand. By incorporating DVFS, the supply voltage and operating frequency of a system are adjusted to meet the exact computational demand at a given time. Compared to a traditional power management technique, DVFS offers significant improvement in power consumption. For a very large system, more energy saving can be achieved by multiple-domain DVFS, in which the system is divided into multiple domains with their own dynamic supply voltages and operating frequencies. The prototype will give a base model of how much power will be needed to complete the task as well as provide information that will lead to a specification for the DVFS design. Building a prototype to evaluate and verify sub system and overall system design. We are using a commercial off the shelf or COTS system with an integrated radio to verify antenna and sensor design. As well as a radio to verify the sensor and also will be used to verify the antenna design. A novel encoding design will be developed to provide low power operation while maintaining transmitted information integrity. Upon completion of the project Rodney will have created a bidirectional prototype that will prove system viability as well as functional testing of antenna and sensor design.

21	**Evaluation of Network-on-Chip Architectures Using a Flit-Level Wormhole Switching Simulator**	21

Undergraduate Researcher: Danielle Forrest, Soyeun Jung and David Noel

Coauthors: Partha Pande

Home Institution, Major, Class Standing: Gonzaga University, Computer Science, Junior

Abstract:

System-on-chip designs have evolved as multiprocessor system-on-chip platforms have grown in popularity. However, many of these MP-SoC designs face challenges in scalability as linear increases in power and wire complexities produce exponential wire delays. Due to the power and wire constraints of these designs, scalable communication methods that feature modularity and parallelism have become desirable features of MP-SoCs. Network on-chip (NoC) platforms offer such scalable communication-centric interconnection fabric that increases the efficiency of the interconnection network in a multi-core chip.

In this research, we aim to investigate the design trade-offs of common NoC architectures with regards to efficiency in network communication. The various NoC architectures of interest in this paper are SPIN, CLICHE, Torus, Folded torus, Octagon, and BFT. In order to establish a fair evaluation method for comparison, we built a simulator that uses a flit-level wormhole switching technique. We demonstrate the design trade-offs by examining several metrics of efficiency using different message injection patterns. The key evaluation metrics used to compare efficiency are based on the desired characteristics of low transport latency and high message throughput for an on-chip network.

22	Dynamic Power Optimization of VLSI Bus Interconnects Based on Skewing-Based Crosstalk Minimization	22

Undergraduate Researcher: Mauricio Jimenez

Coauthors: Dae Hyun Kim

Home Institution, Major, Class Standing: Washington State University, Computer Engineering, Senior

Abstract:

Modern very-large-scale integration (VLSI) circuits contain numerous long, wide buses routed over the entire layout area. Due to very high routing complexity, buses are routed along bus guides before non-bus nets are routed. Use of bus guides provides various benefits in the bus routing such as delay matching and routing time reduction. However, the nets in a bus suffer from serious crosstalk, so various crosstalk minimization methodologies have been proposed in the literature. Most of the methodologies utilize encoding at transmitters and decoding at receivers to avoid the two worst-case switching patterns (HLH->LHL and HLL->LHL) among three adjacent nets. However, these methodologies require additional hardware for encoding and decoding logic, which causes area overhead. In addition, they require insertion of the encoding and decoding logic into their hardware-description language (HDL) source code. However, only long buses require the encoding/decoding logic and it is very difficult to accurately estimate the length of each bus without physical design of the entire circuit. Thus, designers should iterate several times between the HDL coding and the physical design steps several times to bring the layout information (the length of each bus) back to the HDL source code, update the code (insertion and removal of the encoding/decoding logic for each bus), and re-layout the code.

Skewing signal delay is a promising crosstalk minimization methodology proposed recently. The skewing-based crosstalk minimization shifts rising and falling signals properly to maximize (or minimize) the waveform alignment between two adjacent nets switching in the same direction (or opposite directions). However, all the skewing-based crosstalk minimization algorithms ignored timing constraints, so they were not practical at all. In this project, we propose a skewing-based crosstalk minimization algorithm taking timing constraints into account to reduce the dynamic power consumption of modern VLSI bus interconnects.

23	A Filter Bank of high-Q bandpass filters to find Fourier Series Coefficients for TRDMA system	23

Undergraduate Researcher: Jinyanzi Luo

Coauthors: Ben Belzer

Home Institution, Major, Class Standing: Bellevue College, Electrical Engineering, Junior

Abstract:

A Wireless Network-on-Chip (WiNoc) system that employs Time-Reversal-Division-Multiple-Access (TRDMA), which takes the advantage of the multi-path effect of wireless communication to spatially and temporally focus a signal's energy between transmitting and receiving antennas, can reduce latency and power consumption over architectures that reply on omni-directional antennas with token-passing wireless medium access control protocols. Previously proposed TRDMA systems utilized digital sampling, which is not practical for WiNoCs due to extremely short-duration on-chip impulse responses. Therefore the impulse response must be learned via an analog circuit. Previous researches have showed that a 30th order Fourier series (FS) approximation can adequately approximate an indoor cellular impulse response. A time-reversed impulse can be find by inverting the sine components of the FS expansion. Tunable high-Q band pass filters are designed to calculate the FS coefficients. This project investigates design of a filter bank in Cadence (a commercial circuit simulation software package) each with tuned nth harmonic fundamental frequencies to compute the an and bn FS coefficients. The input signal is the impulse response from a Finite Difference Time Domain simulation of on-chip wireless transmission. Cadence will then generate a waveform input from the impulse response, and through the filter bank, each filter finds a pair of FS coefficients by sampling the filter output at exactly the duration of the impulse response, and storing the resulting output level on a capacitor. The time-reversed versions of the impulse response are computed by driving the filter bank input with an impulse, and using inverters to reverse the sign of the sine FS coefficients. The effect of filter design parameters, such as the Q-factor (sharpness of frequency selectivity), on the FS approximation will be investigated.

24	**Finite Difference Time Domain Simulation of Time-Reversal Division Multiple Access for Wireless Networks on Chip**	24

Undergraduate Researcher: Catherine Oseguera

Coauthors: Ben Belzer, Nick Eide

Home Institution, Major, Class Standing: La Salle University, Mathematics, Senior

Abstract:

Wireless networks-on-chips (WiNoCs) for multicore systems on chips have been proposed to reduce power and latency compared to wired networks on chip. While other WiNoCs rely on token passing to reach their destination, the proposed WiNoC utilizes Time Reversal Division Multiple Access. TRDMA creates a channel between the sending and receiving pair thereby eliminating the token passings and reducing power consumption. Previous attempts at developing this WiNoC have not employed scaling and resampling of the time reversed signal being sent.

To find the factors for the rescaling and resampling, a narrow Gaussian pulse was sent from a transmitting antenna (Tx) to a receiving location (Rx) a few mm away in free space using Finite Difference Time Domain (FDTD) software. The voltage component of the original sent signal was scaled appropriately. Using the Savitzky Golay filter the derivative of the curve produced by the voltage component could be taken and was scaled as well. The resulting two vectors of the Gaussian curve and its derivative were resampled at half the rate of the original. The resultant matrix was run through FDTD software as the source and matched the original received Gaussian pulse.

To test these scaling and resampling factors, a narrow Gaussian pulse of 692 timesteps was sent on a simulation of a silicon chip with a copper ground plate to a receiver about four mm away. The received impulse was then time reversed and the voltage component and its derivative were rescaled and resampled as they were in free space. The resultant source was sent back from the Rx to the Tx. We anticipate the received time-reversed impulse will produce a copy of the original Gaussian pulse. Further studies will investigate the effect of approximating the time-reversed impulse response with a Fourier series.

25	Energy Efficiency in Multi-core Systems with Phase-Based DVFS	25

Undergraduate Researcher: Jonah Simon

Coauthors:

Home Institution, Major, Class Standing: Washington State University, Computer Science, Junior

Abstract:

Reducing power consumption on Chip Multi-core processors is a growing challenge in high performance computing systems. Exascale computing, which preforms enormous amounts of computations, incurs high cooling costs and necessitates a low fault tolerance. Reducing power consumption requires lowering voltage and frequency (V/F) levels, which results in increased execution time. The well-known technique of Dynamic Voltage and Frequency Scaling (DVFS) is used to scale down V/F according to a core's workload, which reduces power consumption and incurs performance degradation. DVFS efficiency is measured over varying workloads and when properly designed and implemented, power reduction exceeds performance degradation.

We are using a full system simulator to investigate the energy efficiency of our per-core DVFS methodology. We exploit recurring phases of a benchmark by optimizing V/F level predictions each time we re-encounter a phase. This allows each core to establish its optimal V/F level for future occurrences of the phase after it has been executed a sufficient number of times. Meanwhile, V/F level transitions are minimized, lowering the time and energy costs of locating the optimal V/F Level.

We propose a reactive, phase-based method, which incorporates two time-penalty thresholds, one low and one high. For each phase a core is executed at the highest V/F level, and incrementally lowered on subsequent occurrences to reduce power consumption, unless the lower threshold is exceeded. If both the lower and higher thresholds are exceeded, then the V/F level will be raised to reduce time penalty, however if the time penalty lies between the two thresholds, the V/F level will remain the same. Our results are compared against a similar method which uses only one threshold and concludes optimization when the V/F level is raised for the first time. Additionally, we compare our results against two no-DVFS executions, run at our highest and lowest V/F levels.

Group 4: Atmospheric Chemistry and Climate Change (REU in Laboratory for Atmospheric Research / Civil and Environmental Engineering)

26	Scale Dependencies of Model Estimates for Nitrogen Concentrations in the Western U.S.	26

Undergraduate Researcher: Kayla Besong

Coauthors: Tsengel Nergui, Brian Lamb, Serena Chung

Home Institution, Major, Class Standing: State University of New York Syracuse, Environmental Resource Engineering, Senior

Abstract:

Increasing amounts of reactive nitrogen (N) species present in the atmosphere due to anthropogenic activity has ultimately lead to the degradation of ecosystems and modification of natural processes. Many national parks and forests in the Western United States are particularly vulnerable to elevated N deposition due to their geographic positioning being downwind of major emission sources. Ecologists and natural resource managers rely on regional air quality models in order to predict where and when these disturbances will occur. The Community Multi-scale Air Quality (CMAQ) model driven by the Weather Research and Forecasting (WRF) meteorological model is often used to obtain high spatial and temporal resolutions of N concentration and deposition rate estimates. A performance evaluation of the WRF-CMAQ modeling framework has been carried out for nitrogen dioxide (NO2) concentrations in 17 Western U.S. states across a two-year period (June 1997-December 1998) by comparing model outputs to observational data from the EPA's Clean Air Status and Trends Network (CASTNET). Temporal decomposition was applied in order to observe variations occurring at intraday (21 days) time scales at each site location and setting—rural, suburban, and urban—as well as dominant emissions source. The model's ability to reproduce concentrations increase with length of temporal scale, long-term being the most accurate and intraday the least. Analysis of observational data shows that the variance of diurnal concentrations tends to be most dominant of which the model has a difficulty reproducing. Additional examination reveals better model results for urban and suburban locations than those of rural. The results suggest that improving the model's ability to predict the diurnal profile of NO2, particularly in less populated locations, is to be considered.

27	**Changes in Carbon Dioxide Concentration and Flux Over a Large Southern Inland Water Body**	27

Undergraduate Researcher: Justin Bonds

Coauthors: Raleigh Grysko, Zhongming Gao, Heping Liu

Home Institution, Major, Class Standing: Jackson State University, Meteorology, Sophomore

Abstract:

Inland lakes, being both major carbon sinks and sources, can significantly impact the global carbon cycle. Data collected from an eddy covariance system were used to study diurnal and seasonal variations in concentration of carbon dioxide (CO2) and CO2 fluxes over the Ross Barnett Reservoir, Ridgeland, Mississippi. We chose the data from the following weeks for our analysis: June 4th to the 18th, November 18th to the 24th, and December 1st to the 7th during which significant changes in CO2 concentrations from their averages were identified. The reservoir is surrounded by different types of land covers and land uses such as urbanized, rural, residential areas, suggesting the influences of varying CO2 sources and sinks. Thus, the primary objective of this study is to examine how CO2 concentrations observed on the tower were related to the influence of these sources and sinks, and how CO2 emissions from water responded to changes in CO2 concentrations.

28	**Nitrous Oxide Emissions From Agricultural Sources Using the Nocturnal Storage Ratio Technique**	28

Undergraduate Researcher: Dylan Curtis

Coauthors: Sarah Waldo, Shelley Pressley, Brian Lamb

Home Institution, Major, Class Standing: Washington State University, Civil Engineering, Senior

Abstract:

Agriculture is responsible for 75% of the earth's anthropogenic nitrous oxide (N_2O) emissions, a gas that has 289 times the global warming potential as carbon dioxide. Nitrous oxide emissions are difficult to characterize and predict using field measurements, because of its huge temporal and spatial variability. Primarily due to heterogeneity of soils, N_2O emissions are scattered unevenly throughout agricultural fields. In addition, instrumentation used to detect emissions have only recently been commercialized and are very expensive. Two observation sites for measuring N_2O emissions have been constructed in two agricultural wheat fields located on the Palouse in Washington State. At each site, eddy covariance flux towers measure carbon dioxide (CO_2) fluxes continuously, while N_2O emissions are measured using a series of chambers placed over the surface of the field. Previous research from the regional approaches to climate change project (REACCH) project (Waldo, 2016) showed reasonable agreement for N_2O emissions between the chambers and the flux gradient method (a micrometeorological technique) at one of the two sites, however, agreement was not as good for the second site. This study attempts to further develop an understanding of N_2O emissions from croplands in the inland Pacific Northwest, by implementing the nocturnal storage ratio (NSR) technique. By concentrating solely on stable nighttime N_2O emissions, and using ambient N_2O and CO_2 concentrations, N_2O fluxes will be calculated and compared with chamber emissions.

29	**Methane and Carbon Dioxide Concentration Patterns over Washington State University's PACCAR Building**	29

Undergraduate Researcher: Brandon Daub

Coauthors: Nathan Sparks, Eric Russell, Zhongming Gao, Raleigh Grysko, Heping Liu, Brian Lamb, Von Walden, Tom Jobson

Home Institution, Major, Class Standing: Millersville University of Pennsylvania, Meteorology, Senior

Abstract:

Measurements were made from a 10-meter tall meteorological tower atop the roof of Washington State University's PACCAR Environmental Technology Building from June 28 to July 5, 2016. Meteorological quantities, including wind speed and direction, were measured along with methane (CH4) and carbon dioxide (CO2) concentrations. CH4 and CO2 concentrations were analyzed to understand diurnal patterns and determine if there are any wind direction dependencies. The Grimes Way Steam Plant is located 0.25 kilometers east of the measurement site and it is a potential source for CH4 emissions. Five-minute averaged data from the period were analyzed to relate CH4 and CO2 concentrations to wind speed and direction and determine the correlation between CO2 and CH4 concentrations. The primary goal of this study is to compare the variations between the concentrations of CH4 and CO2 in relation to wind direction, wind speed, and turbulence. The PACCAR building is surrounded by different landscapes including parks, buildings, and parking lots from different directions. The second goal of this study is then to study how CO2 fluxes vary with changes in land uses.

30	A quantification of VOC emissions from carpet in a residence with a high level of formaldehyde	30

Undergraduate Researcher: Cari Gostic

Coauthors: Tom Jobson, Yibo Huangfu

Home Institution, Major, Class Standing: Cornell University, Atmospheric Science, Senior

Abstract:

The Indoor Air Quality (IAQ) study at Washington State University strives to better understand the link between indoor air quality, health, and climate change. To combat climate change, building envelopes are tightened to reduce energy losses from heating and cooling. This results in reduced ventilation rates, and consequently, a greater buildup of pollutants from indoor sources. This project seeks to quantify the contribution of VOC emissions from carpet to indoor air pollution in a house (H002) in which high levels of formaldehyde were measured during the IAQ study. This initial analysis shows an average formaldehyde level of 30.1 ppbv. VOC emissions from three carpet samples are measured in an environmental chamber using a PTR-MS and a GC-MS. This experiment is unique because it compares emissions from a 3 year-old carpet (from H002) to emissions from new carpet samples. VOC emissions are also quantified under elevated O_3 concentrations, and under the application of UV light. Under normal chamber conditions, all three carpet samples meet the Carpet and Rug Institute's "Green Label Plus" standards. O_3 addition causes concentrations of some primary emissions to decrease and spurs greater emissions of some secondary pollutants. UV light causes emissions of most VOCs to rise considerably, though temperature increase with the activation of the UV light likely influences this result. A simulation of the indoor concentration of formaldehyde in H002 reveals that carpet emissions alone cause a concentration of 10.3 $\mu g/m^3$ of formaldehyde in H002, which is an unhealthy level for long-term exposure according to standards cited by California's OEHHA and the U.S. EPA. However, the expected concentration of formaldehyde due to carpet emissions alone is 68% lower than the average measured formaldehyde concentration in H002.

31	An Evaluation of ClearSky2&3 for the RARE 2013 Field Burning Campaign	31

Undergraduate Researcher: Tariq Hamzey

Coauthors: Joseph Vaughan, Brian Lamb

Home Institution, Major, Class Standing: Ohio State University, Applied Physics, Senior

Abstract:

Agricultural fields are commonly burned post-harvest as a cost-effective approach to removing crop residue, which favors the spread of plant pests and diseases. Emitted PM2.5, particulate matter with an aerodynamic diameter equal to or less than 2.5μm, poses respiratory health risks to populations downwind of burns. Driven by Weather Research and Forecasting (WRF) meteorology and the Sparse Matrix Operator Kernel Emissions (SMOKE) system, the ClearSky2 (CS2) smoke dispersion model predicts hourly PM2.5 surface concentrations from default burn scenarios on a 4-km grid for the Pacific Northwest region. The RARE 2013 field burning campaign measured PM2.5 concentrations for burns in Nezperce, ID and Walla Walla, WA, against which CS2 results were examined. While CS2 accurately simulated smoke plume arrival time and duration, it generally underestimated concentrations. A higher resolution version of ClearSky, ClearSky3 (CS3), which runs on a 1.33-km grid, performed similarly but was more accurate at modeling concentrations. The RARE 2013 measurement locations were no more than 1km away from their respective burns, so they often both occupied the same grid cell, though less so in the CS3 runs. ClearSky-predicted concentrations are uniform within cells, and because the model instantly diffuses emissions within the source cell, it artificially dilutes dense plumes near the burns. Thus, ClearSky does not adequately forecast PM2.5 concentrations at distances less than a few kilometers. Assessing ClearSky results with observations at greater distances would reduce the effect of ClearSky's artificial dilution of dense plumes and should better reflect PM2.5 observations. Future research should also consider nesting a finer resolution grid at burn sites for more precise wind fields over complex terrain.

32	Analysis of a 2012 Ozone Episode in the Spokane - Coeur d'Alene Area	32

Undergraduate Researcher: Eric M Lopato

Coauthors: Vikram Ravi, Brian Lamb, Serena Chung

Home Institution, Major, Class Standing: St. John's University, Chemistry and Environmental Studies, Junior

Abstract:

The National Ambient Air Quality Standard (NAAQS) for daily maximum 8-hour ozone was recently reduced from 75 ppb to 70 ppb, which increases the possibility for exceedances in areas not previously known for ozone issues. The Spokane – Coeur d'Alene Airshed is an example where elevated ozone has occurred at three different ozone monitoring sites in recent years. To investigate the nature of elevated ozone episodes in the Spokane region, we selected an episode from July 2012 when there was no obvious impact from wildland fires on ozone in the region. This episode spans July 1st through the 14th. HYSPLIT back trajectories were created and combined with AIRPACT-5 simulated ozone and precursor concentrations in order to investigate the production of ozone from source to monitor locations. Meandering back trajectories and the simultaneous occurrence of peak ozone levels at all three monitor sites, including one urban site and two rural sites located northeast and southwest of the urban center, suggested elevated ozone was produced under stagnant summertime conditions where precursors from the Spokane-Coeur d'Alene corridor lead to widespread ozone production in the region. Further work using emission reduction simulations is needed to assess the relative importance of volatile organic compounds (VOCs) versus nitrogen oxides (NOx) emissions for ozone production, however preliminary data analysis points towards VOC-limited ozone production.

33	Air Trajectory Analysis for Forecasting Future Air Quality	33

Undergraduate Researcher: Allison Ronan

Coauthors: Von Walden, Yunha Lee

Home Institution, Major, Class Standing: Pennsylvania State University, Meteorology, Senior

Abstract:

Understanding the movement of an air parcel (hereafter, referred to as an air trajectory) is important for understanding air pollution. The air trajectory determines where the air parcel passes over an area with air pollution and how the air transports air pollutants such as particulate matter (PM) into the downwind regions. Understanding how air trajectories could change in coming decades will help to improve future air quality projections.

We used the MACA (Multivariate Adaptive Constructed Analog) dataset, i.e., the downscaled climate data with 4 km x 4 km grid size from the past, present and future climate model simulations. Using the u (west-east) and v (south-north) components of winds from the MACA's future climate data, back trajectories were calculated for several locations in the Pacific Northwest region. We evaluated the back trajectories using the MACA against an air trajectory model from the National Oceanic and Atmospheric Administration (NOAA) and HYSPLIT4 (Hybrid Single-Particle Lagrangian Integrated Trajectory). We ran HYSPLIT4 with historical meteorology datasets before the year 2005 from the Eta Data Assimilation System (EDAS) meteorology reanalysis data and the Weather Research and Forecasting (WRF) model outputs. The WRF model output has a 4 km x 4 km grid resolution, while the EDAS reanalysis data has a 40 km x 40 km grid. Compared to EDAS, the WRF model is better for predicting accurate wind flow patterns due to its finer grid size. Thus the air trajectories computed with WRF can be used as a benchmark. Based on these comparisons, we can assess the ability of MACA to produce accurate back trajectories. The MACA back trajectories may provide useful information on potential future air trajectories, which can then be used to project better air quality forecasts in the future.

34	**Comparison of Surface Energy Budget and Carbon Dioxide Flux between Urban and Agricultural Environments.**	34

Undergraduate Researcher: Nathan Sparks

Coauthors: Brandon Daub, Heping Liu, Eric Russell, Zhongming Gao, Raleigh Grysko, Jinshu Chi

Home Institution, Major, Class Standing: Washington State University, Civil Engineering, Junior

Abstract:

A 10 meter eddy flux tower was erected on the roof of the PACCAR Environmental Technology Building at Washington State University. Instruments placed on the tower include multiple 3-D sonic anemometers, a compact weather station, a two-channel radiometer, and an open path gas analyzer. A similar system was erected at the Cook agronomy farm 7.9 km to the northeast of the Paccar site. The objective was to analyze latent and sensible heat flux and CO2 flux to explore the influence of an urban landscape on surface energy budget and CO2 flux. Data were recorded from June 10 to June 17, 2016. The CO2 flux at the rooftop site had more variability than at the agricultural site. CO2, sensible and latent heat flux at both sites behaved similarly on a mean diurnal cycle. There was greater negative sensible heat flux during nighttime hours at the farm site than at the rooftop site. Latent heat flux fluctuated to a greater degree at the rooftop site compared to the farm site. Sensible heat flux was roughly equivalent between the two sources.

35	**Comparison of AIRS and MODIS precipitable water vapor retrievals with data from Arctic locations**	35

Undergraduate Researcher: Pyxie Star

Coauthors: Von P. Walden, Sarah Y. Murphy, Shima B. Shams

Home Institution, Major, Class Standing: The Evergreen State College, Physics, Junior

Abstract:

Melting of Earth's major ice sheets is contributing to global sea level rise. Thin, low level liquid water clouds over Greenland and the Arctic increase near-surface temperatures and have been shown to influence the record melt event of the Greenland Ice Sheet (GrIS) in July 2012. Observation and characterization of atmospheric water vapor are crucial to understanding the forcing of the GrIS and Arctic sea ice melt. In 2010, the ICECAPS (Integrated Characterization of Energy, Clouds, Atmospheric State and Precipitation at Summit) project established a suite of instruments at Summit, the highest point on the GrIS and the Arctic as a whole. Retrievals of precipitable water vapor (PWV) were obtained from the Humidity and Temperature Profiler (HATPRO) microwave radiometer (MWR) at this location for July 2012 through September 2015. Additionally, from January to July 2015 the Norwegian Young Sea Ice Cruise (N-ICE) project froze the research vessel Lance into the southern edge of Arctic sea ice. Radiosondes launched from the ship measured relative humidity profiles from which PWV values were derived for this study. To verify satellite water vapor products, these two sets of ground-based observations were compared with PWV retrievals from MODIS and AIRS instruments onboard two of NASA's polar orbiting satellites, Aqua and Terra. Preliminary results show the satellite values to be consistently higher than ICECAPS retrieval daily means. Further analysis will determine the seasonal dependence of difference magnitudes. The atmosphere above Lance is wetter than that over Summit, which may result in a stronger correspondence between N-ICE and satellite data.

36	Lewiston-Clarkston Valley Air Sampling Measurement Campaign	36

Undergraduate Researcher: Jaime Torres

Coauthors: Shelley Pressley, Thomas Jobson, Patrick Robichaud

Home Institution, Major, Class Standing: University of Texas El Paso, Industrial Engineering, Senior

Abstract:

The purpose of this study is to identify the major causes for the elevated levels of formaldehyde (HCHO) and acetaldehyde in the Lewiston-Clarkson valley. This study is based on a previous air toxics study done from May 2006 to April 2007 by the Nez Perce Tribe Environmental Restoration and Waste Management Air Quality Program and the Idaho Department of Environmental Quality which suggested that levels of formaldehyde were too elevated in the Lewiston-Clarkson valley and that a further study should be conducted. Formaldehyde and acetaldehyde are known to be carcinogens that after continuous exposure pose a combined cancer risk level resulting in 89 extra cancers per one million people exposed. Probable causes of high contamination in the area include a paper mill company, car emissions and secondary formation of formaldehyde.

In order to identify concentrations of formaldehyde and acetaldehyde, three sites were chosen in the Lewiston-Clarkson valley where two 12-hour air samples, as well as meteorological data, were collected per day for a 4-week period. The sites consist of two auxiliary sites that were strategically chosen because of their upwind and downwind components and an intensive site. The intensive site hosts a collection of instruments in a trailer, the Mobile Atmospheric Chemistry Laboratory, which makes continuous measurements of HCHO and other gases such as CO and NO.

Preliminary data demonstrates that formaldehyde levels are highest between 6:00 to 9:00 am, this has a correlation with the amount of traffic in the studied area during this time period. It may be possible that car emissions of CO, NOx and SO2 react with other gases to form formaldehyde. As this investigation continues, new data will help us analyze the main causes for the high levels of air toxics.

37	**Measuring CO2 emissions as a Basis for Understanding Indoor Air Quality and Ventilation Rates**	37

Undergraduate Researcher: Mercedes Winfrey

Coauthors: Von Walden, Patrick O'Keeffe

Home Institution, Major, Class Standing: University of Arkansas Pine Bluff, Physics, Junior

Abstract:

Abstract. Washington State University (WSU) is collaborating to make Spokane, Washington a leader in smart city technologies. The Smart Cities Project will use smart sensor technology to provide better management of resources (such as energy and water) while also promoting health and well-being in the city. The Laboratory for Atmospheric Research at WSU is developing a sensor package for monitoring air quality for the Smart Cities Project, using various sensors to measure carbon dioxide, ozone, nitrogen dioxide, and particulate matter (particles from smoke and pollution). These sensors have been interfaced to a Raspberry Pi computer and are being mounted into a weather-proof 3-D printed container. As an initial test, we will measure the indoor air quality and ventilation rate with a cost-efficient CO2 sensor within a laboratory in the new PACCAR Environmental Technology Building at WSU. Carbon dioxide will be released into the lab periodically, and we will analyze the data on how the gas is disbursed within room. The rate at which the carbon dioxide dissipates in the lab will allow us to study the ventilation rate. The accuracy of the data from the sensor package will be compared to a more accurate and expensive LI-COR 820 Closed-Path CO2 sensor, which is currently being used in a national study of the indoor air quality of residential homes. Lastly, the various sensors will be mounted into the weather-proof container for eventual deployment on light posts in Spokane as part of the Smart Cities Project.

Group 5: Plant Genomics and Biotechnology (Summer Undergraduate Research Experience)

38	Evaluation of biochar on plant growth and development	38

Undergraduate Researcher: Jessica Brar

Coauthors: Ryan Christian, Corbin Schuster, Richard Sharpe, Amit Dhingra

Home Institution, Major, Class Standing: Heritage University, Environmental Science, Senior

Abstract:

Biochar has recently drawn interest as a soil amendment, with many largely unsubstantiated claims of its efficacy. Biochar is a form of activated charcoal that is created from organic material through pyrolysis: a process of thermal decomposition in the absence of oxygen. Current research indicates that, when used as a soil amendment, biochar can aid in water retention and nutrient binding capacity. Since biochar is largely recalcitrant, this additional porosity and holding capacity can potentially last for hundreds of years. This has led to claims that biochar can reduce the need for both fertilizer and water while increasing productivity and growth in crops. However, these claims are not rigorously tested, and biochar's chemical properties may vary greatly depending on the feedstock used in pyrolysis and the concentration of biochar that is applied. This research seeks to create a controlled study to test these claims and to provide more specific recommendations for the agricultural community. It also establishes methods that will be used to test additional biochar-soil compositions. In this experiment, 'Oregon Spring' tomatoes were subjected to six concentrations of biochar, ranging from zero percent to twenty-five percent in a base of SunShine mix #2 potting media. As the tomatoes grew in the greenhouse, high resolution images were recorded every other day to track growth. These photographs were analyzed using ImageJ to quantify growth of each tomato plant. Growth rates were then compared across treatment types. During the early stages of growth, the tomatoes that were treated with biochar experienced significant stunting. This evidence runs contrary to the claims surrounding biochar, and may indicate toxic byproducts or fertilizer burn.

39	Evaluation of N. tabacum lines expressing Malus ALBINO3	39

Undergraduate Researcher: Chelsea Crabb

Coauthors: Ryan Christian, Amit Dhingra

Home Institution, Major, Class Standing: Seattle Pacific University, Cellular and Molecular Biology, Junior

Abstract:

ALBINO3 (Alb3), a membrane integrase protein, has long been known to affect assembly of integral chloroplast proteins. However, a truncated Alb3 homolog from apple produced phenotypes, including altered chloroplast morphology, decreased chlorophyll, increased non-photochemical quenching and lengthened flowering time. Interestingly, this truncation occurred before the integrase domains, indicating a secondary function to the N-terminus. Preliminary results indicate that calcium homeostasis is involved, however further work is necessary to uncover how the N-terminus elicits this effect. Stepwise truncations of ALBINO3 were produced to identify which regions of the ALBINO3 N-terminus are responsible for these phenotypes. Biolistics particle bombardment was used to transform the stepwise truncations of Alb3 into the chloroplast genome of Nicotiana tabacum. This project aims to characterize the insertional positions of the transgenes within the chloroplast genome, and to verify gene sequence. DNA was extracted with the CTAB method and purified, after which polymerase chain reaction analysis was performed to confirm position and identity of desired ALBINO3 isoforms in each tobacco line.

40	**Establishing in vitro resources for Vitis vinifera 'Pixie' transformation**	40

Undergraduate Researcher: Shirley Guzman

Coauthors: Kathie Nicholson, Amit Dhingra

Home Institution, Major, Class Standing: University of Idaho, Exercise Science and Health, Junior

Abstract:

Powdery mildew is a fungal disease that affects a wide range of plants and is a significant problem for strawberries and grapes. Ongoing work in the laboratory is focused on improving strawberries and grapes via genome editing so that they are able to build natural resistance to powdery mildew. For this project two strawberry genotypes, Fragaria vesca 'Yellow wonder' and Fragaria x ananassa 'LF9' have been used. In grapes, Vitis vinifera 'Pixie' which is a dwarf genotype has been utilized. Pixie is an offspring of Pinot noir and is an ideal candidate for research due to its dwarfing characteristics. Previously, a method to perform leaf-based regeneration in Pixie was reported from the lab which can now be utilized to perform genetic engineering in this plant. The first stage of the project is to utilize in vitro techniques to maintain and grow Pixie plants that will subsequently be used for transformation. Micropropagation of Pixie is essential because a significant amount of plant material, referred to as explants, is needed to perform a transformation experiment. While the propagation of strawberries is straight forward as one plant will supply several explants, grapes are more difficult, as the explant material must come from very specific leaves. Only the newest apical leaves between 3 and 6 mm in diameter can be used for leaf-based regeneration, therefore it takes several plants and precise timing to obtain enough explant material for a transformation. The goal of this project is to propagate large amounts of Pixie material to perform transformation experiments with grape and develop a variety with resistance to powdery mildew.

41	Effects of chemical compounds on germination of legume and grass cultivars	41

Undergraduate Researcher: Brennan Hyden

Coauthors: Bruce Williamson, Ryan Christian, Nic Conti, Amit Dhingra

Home Institution, Major, Class Standing: Washington State University, Agricultural Biotechnology, Junior

Abstract:

Germination rate and early plant growth are critical components in achieving high crop yields with the best efficiency, but many crops are hampered by seed dormancy. There is a pressing need in the turfgrass and forage crop industries for chemical stimulants of early growth to reduce the time before 100% canopy coverage with the least amount of seed possible. This study investigated the effects of two potential chemical germination stimulants (RC1 and RC2) on the germination and growth rate of three genotypes of grass and two genotypes of forage legumes. The two ripening compounds are hypothesized to aid in shortening dormancy and thereby allow for faster germination and more vigorous early growth. Monocots (grasses) and dicots (forage legumes) were investigated in order to explore if the effect was consistent across divergent evolutionary lineages. Seeds of the five varieties were coated in a mixtures containing each compound at concentrations ranging from 0% to 20% in a base matrix of filler agent. Following germination, images were taken daily for 10-15 days and the total shoot area was analyzed using ImageJ. At the end of the experiment, dry biomass measurements were collected. The data indicate increased coverage among the grass cultivars exposed to the RC1 treatments and increased coverage among the legume cultivars when exposed to RC2. These results may be used to help identify target genetic pathways and create improved germination treatments to be used for forage crops as well as food crops such as corn, wheat, rice, and soybean

42	**Genetic Classification and Identification of old apple genotypes in the Kwina Estate – a move towards food sovereignty and security**	42

Undergraduate Researcher: Na'ta'ne Miles

Coauthors: Daniella Guzman, Ted Kisha, Amit Dhingra

Home Institution, Major, Class Standing: Northwest Indian College, Environmental Science, Senior

Abstract:

Lummi Tribal Nation is acknowledged for having a distinguished tribal fishing history, but little is known about the historical data regarding the early agriculture in the area. Northwest Indian College (NWIC) was founded on the Kwina Estate in 1973, which was formerly the Lummi Indian School of Aquaculture. Originally a training program developed to prepare technicians for employment in tribal based aquaculture operations; currently the only tribal college in the Pacific Northwest serving Washington, Oregon, and Idaho. Food security is a critical concern of national magnitude. In order to make well informed decisions for their community, it is imperative for Lummi Nation to establish a clear record of agriculture history which is conducive to their community development. This is also an issue which concerns tribal sovereignty by influencing tribal leadership decisions with respect to food sovereignty initiatives, environmental policy – furthermore responding to the emerging needs in the progressive advancement of NWIC's environmental science program. This study is being conducted to genetically classify and identify the old apple varieties growing in abandoned orchards on the NWIC campus. DNA was isolated from leaf tissue collected from trees in the Kwina estate grove using Promega's © Wizard Magnetic 96 DNA Plant System. DNA was used for Target Region Amplified Polymorphism (TRAP) reactions. TRAP analysis is used to identify polymorphic markers from established database information of expressed sequence tags around targeted candidate gene sequences. For each TRAP reaction, scorable fragments are generated when separated on a polyacrylamide sequencing gel. This method has proven to be beneficial in genotyping and interpreting the structure and genetic diversity of a given population. It is our intention to fill in the missing gaps of agricultural history of the Lummi Indian Reservation in hopes to build upon the cultural and historical knowledge base of the past.

43	Evaluation of Molecular Markers for Root Rot Resistance in Pea (Pisum sativum)	43

Undergraduate Researcher: Corbin Schuster

Coauthors: Bruce Williamson, Jessica Brar, Richard Sharpe, Amit Dhingra

Home Institution, Major, Class Standing: Heritage University, Biomedical Science, Junior

Abstract:

Pisum sativum (peas) is a popular crop that has seen a drastic decline in yields in the past few decades. One of the main causes of the decline is due to Fusarium root rot, which is mainly caused by the pathogen Fusarium solani f. sp. Pisi (Fsp). Ongoing work in the laboratory has identified 46 genes in peas that are differentially expressed after being challenged with Fsp. By aligning the sequences of the 46 candidate genes from the tolerant and the susceptible genotypes, potential SNPs (single nucleotide polymorphism) have been identified. There are eight genotypes that are phenotyped and classified into two main groups: tolerant (Aragorn, Banner, Bolero, and DSP) and susceptible (5001, 5003, 5004, and 5007) to this fungus. The objective of the study is to identify the restriction enzymes that differentially digest the 46 genes in the eight genotypes according to the specific predicted SNPs in the DNA. Applying the program CisSERS on the sequence of all the 46 candidate genes from the RNAseq data, theoretical restriction sites and digest patterns were visualized. We identified six restriction enzymes which will digest the DNA at the specific locations where the SNPs are predicted to exist. Utilizing Polymerase Chain Reaction (PCR) we were able to amplify the targeted region in the candidate genes. Using this DNA, we will perform restriction enzyme digests to evaluate the restriction digestion patterns in susceptible and tolerant genotypes. Validation of the SNPs through this approach is expected to enable the development of CAPS molecular markers for root rot resistance that can be utilized in pea breeding experiments.

Group 6: Gerontechnology-Focused Summer Undergraduate Research Experience (GSUR)

44	**Development and Usability Testing of the Digital Memory Notebook for iOS**	44

Undergraduate Researcher: Eric Chen

Coauthors: Jessamyn Dahmen

Home Institution, Major, Class Standing: Washington State University, Computer Science, Senior

Abstract:

Memory notebooks have been shown to help the mildly cognitive impaired (MCI) with daily tasks. While a digital memory notebook takes advantage of modern technology, smart home technology is the next promising step in assisting those suffering from MCI. The new iteration of the Digital Memory Notebook will be developed on iOS and will not only be more user-friendly, but will also be integrated with smart home technology, making it more helpful and less intrusive. It will be developed and tested on older adults with MCI from the ages of 60-80.

When developing for a user base with such diverse but strict visual and cognitive requirements in consideration, the design process of the app should focus on ease-of-use. We repeatedly tested and met to discuss what essential features users wanted and how as we could include them in a way that was not intrusive and confusing to use. Then, using the Objective-C and Swift 2 programming languages we would make changes and deploy an improved app on iPads for further usability testing.

I expect that through adding what users from the first iteration want, the Digital Memory Notebook will become more useful and thus more useable. With more features like smart home integration and an integrated notepad, not only will users find the app simplier to use but usable in more ways than before.

45	The Development of a User-Centered Digital Memory Notebook	45

Undergraduate Researcher: Brittany Cole

Coauthors: Thao Vo, Jessamyn Dahmen, Maureen Schmitter-Edgecombe

Home Institution, Major, Class Standing: Washington State University, Psychology, Senior

Abstract:

Paper and pencil memory notebooks can help individuals experiencing memory impairment maintain functional independence. Memory notebooks can support everyday memory by serving as an external aid, where past activities can be recorded to aid retrospective memory and future events scheduled to aid prospective memory. Teaching an individual with memory impairment to use a memory notebook, however, can be challenging. The Digital Memory Notebook (DMN) is being designed to further reduce the memory load of its users by integrating added benefits of other assistive technologies, such as text support and reminders, to increase the frequency with which the memory notebook is used. A paper mockup and one earlier version of the DMN have been tested with older adults, and suggested improvements integrated into the current app. To test the improved usability and function of the DMN, two older adults with histories of Traumatic Brain Injuries (TBI), one older adult with Mild Cognitive Impairment (MCI), and one older adult caregiver of a person with dementia participated in the second iteration of interface testing. Participants completed task scenarios (e.g., creating a To Do list, responding to prompts) on the tablet based app while providing feedback about their experience, after which quantifiable data was collected. Example user feedback included the inclusion of an instructional brochure and high priority indication options for tasks. The use of a Likert scale (i.e., 1-strongly satisfied to 7- Strongly Dissatisfied) indicated that participants were generally satisfied (average rating of 2.38) on ease of use, completion time, and support information. Future work will focus on continuing to improve the user interface, integrating the DMN with smart environment sensors to track and assist in activities of daily living, and distribution of the app in iOS and Android stores for the benefit of individuals experiencing cognitive deficits.

46	**Aiding everyday activities with prompting technology: A qualitative analysis of dimensia participants' experiences**	46

Undergraduate Researcher: Kelsey Dammeyer and Brooke Robinson

Coauthors: Maureen Schmitter-Edgecombe, Shelly Fritz, Rachel Braley

Home Institution, Major, Class Standing: Washington State University, Psychology, Senior

Abstract:

Older adults with declining cognition have a harder time completing instrumental activities of daily living (IADLs), such as cooking and managing finances. Prompting technologies, which include in-home devices that can assist older adults in completing these activities, help to prolong independent living. This study aims to understand how persons with dementia respond to voice prompting delivered within a smart home environment. Seventeen older adults with dementia were filmed while completing eight scripted IADLs in a smart home environment (e.g., wash countertops, change a light bulb). Upon making a mistake during task execution, the examiner provided a pre-recorded prompt to assist the individual with completing the task. Prompts provided an increasing amount of direction, starting with a less directive verbal prompt (i.e., a suggestion orienting the individual back to the task). If the indirect prompt did not result in successful task completion, then a more directive verbal prompt (directly telling the individual what to do) was provided. If the more directive verbal prompt failed, a multimodal prompt, which consisted of the direct verbal prompt displayed simultaneously with a short video showing how to complete the activity, was provided on a nearby computer. Two students viewed the footage of participants attempting the eight IADLs and made detailed observations of what was happening in the videos and how the individuals with dementia were responding to the prompting. In this way, the experience of each individual with dementia with the prompts was portrayed through the unique views and interpretation of each student. Qualitative descriptive analyses will be reported with themes that identify how people with dementia respond to smart home voice prompts when completing everyday activities. These results will contribute to further improvement in assistive technology for older adults with dementia.

47	The Night Out Task: Everyday Functioning Assessment of Older Adults and Younger Adults	47

Undergraduate Researcher: Alexis Fuller

Coauthors:

Home Institution, Major, Class Standing: Washington State University, Psychology, Senior

Abstract:

Across the aging spectrum, cognitive functioning varies as a result of a number of genetic and environmental factors. As a general trend, however, there is a positive association between increasing age and decline in specific cognitive abilities (e.g., executive functioning, speeded processing). A decline in cognitive functioning can negatively impact the way older adults complete tasks in everyday life, making strategies that can deter this decline vital as the senior population continues to grow larger. This study aims to evaluate age-related performance differences on a laboratory task that focuses on the capacity to engage in more real-world complex planning, problem-solving and multitasking. To examine this, younger (ages 18-40) and older (ages 60+) adults will complete the Night Out Task (NOT). The NOT requires participants to complete eight different tasks to prepare for a night out (e.g., determine movie start time, prepare a thermos of tea, gather a snack for the movie, etc.). The NOT assesses the ability to follow instructions, plan a complex task, interweave and multitask, all while completing the task as efficiently and accurately as possible. A limited number of testing measures are designed to evaluate everyday functioning while taking place in a laboratory setting, which as a result makes the NOT an important addition into the neuropsychology field. It is expected that the results will demonstrate a significant difference in the younger adult's ability to complete the task more efficiently and accurately than the older adult group. By gaining a better understanding of the process of aging and cognitive decline, the information from this study can be used to encourage future research on assistive technologies that aim to increase the longevity of healthy cognitive functioning.

48	Speech to Text for Monitoring Nutritional Health	48

Undergraduate Researcher: Joshua Kolasch

Coauthors: Niloofar Hezarjaribi

Home Institution, Major, Class Standing: Washington State University, Computer Science, Senior

Abstract:

Diet and physical activity are important for prevention and self-management of many chronic diseases. Self-monitoring is one of the earliest skills in nutrition management; yet, this technique is cumbersome, and adherence is low. Therefore, many researchers focused on automating this task using sensors or applications embedded in smart-phone devices. Mobile sensors such as an accelerometer have been used to detect eating moments and manage physical activity. This technology has low user adaptation and compliance. Mobile application requires users to enter text or take an image of the food using their smartphone. These technologies primarily rely on self-recorded data by end-users. Although it is accurate, it can be tedious at times. In this work, we aim to target the advantages of utilizing speech processing, natural language processing (NLP), and text processing in nutrition monitoring. The current app development converts speech to text using a Google's speech API. The text obtained from speech to text will be processed by NLP module for identifying nutrient information (food names, time of day, and quantity). The tagged items are then cross referenced with entries from a personal database, largely collected from the USDA's database, utilizing 2-tiers string matching algorithm, which calculates and returns their calorie values. The discovery and implementation of API-AI is an improvement over the previous NLP by providing Named Entity Recognition (NER). The primary advantage of this app is that users can record their information at any time and more frequently. For determining the effectiveness of the speech to text module, we evaluated the system in a variety of noisy environments. Preliminary testing has shown mixed results, especially with users who have speech disorders or speak with an odd cadence. Pending the final results it may be better to research an alternative speech to text conversion module.

49	The WORRDS Project: Visually Providing Users with Readable and Meaningful Data from Smart Homes	49

Undergraduate Researcher: Aaron Kwan and Timothy McAleer

Coauthors: Leah Zulas

Home Institution, Major, Class Standing: Washington State University, Computer Science, Senior

Abstract:

The CASAS Smart Home is a helpful tool when it comes to caring for the elderly. The Smart Home retrieves a wide variety of information from the senior citizen, ranging from sleep time, to medication intake, to eating habits. This information is tracked using a complex system of motion trackers, weight sensors, and heat sensors spread throughout the home. On a typical day, hundreds of these sensors are fired off and logged by our computers. With the WORRDS Project, it is our job to take this information and display it to users in an easy and accessible format, mainly through visual elements.

Our graphs will be tailored to each user depending on whether the user is a nurse, a family member, or an administrator of the senior citizen (this group is often referred to as the Circle of Care). Nurses, for instance, prefer to see information in a longer timeline (such as by month or by year) to determine patterns in the senior citizen's habits. Family members on the other hand, would rather see just the most recent couple of days. Due to the vast amount of information being retrieved from the Smart Homes, we selected graphs that best display the data, while still maintaining a simple and easy to read format.

By the end of the project, we hope to establish a strong server containing usernames for all positions in the Circle of Care as well as provide said users with tailored information on their patient.

50	Using Wearable Sensors to Detect Changes in Physical Activity	50

Undergraduate Researcher: Alyssa La Fleur

Coauthors: Jordana Dahmen, Gina Sprint, Douglas Weeks, Diane Cook

Home Institution, Major, Class Standing: Whitworth University, Biochemistry and Mathematics, Senior

Abstract:

Wearable technology has become increasingly popular and is beginning to be utilized in various healthcare disciplines. It is difficult to assess unsupervised physical activity among sensor wearers since individuals can have a subjective understanding of how well they are doing and can either over or under estimate their activity level. In a rehabilitation setting, physical activity monitors such as the Fitbit can gather data about patients that physical therapists can't otherwise observe. In order to detect and analyze physical activity changes participants were given a Fitbit Charge HR for two weeks and asked to wear it at all times. Two different population groups are being tested. There are currently 3 participants at St. Luke's Rehabilitation Institute and 8 participants in the general population of Pullman, WA. The participants at St. Luke's Rehabilitation Institute are mobile-capable elderly rehabilitation patients, and the participants in Pullman's general population are adults between the ages of 18-60. A window based change detection algorithm will be used to analyze the minute by minute data that is collected. The two groups can be assessed to determine if Fitbits are able to detect changes over time in both an inpatient setting and a free-living setting. In addition, comparisons will be made within the groups and between the groups to determine if activity level differences exist between different demographic groups and to evaluate the statistical significance of our findings.

51	Activity-Aware Medication Adherence	51

Undergraduate Researcher: Amir Hossein Rezamand

Coauthors: Hassan Ghasemzadeh, Ramin Fallahzadeh, Ryan Philip Torelli

Home Institution, Major, Class Standing: Washington State University, Electrical Engineering, Sophomore

Abstract:

One of the problems that older adults with chronic conditions face is medication adherence. Currently, adults with conditions such as diabetes, chronic back pains, arthritis, etc are forced to take multiple types of medicines, some several times a day or with specific conditions for ingestion. This poses a serious problem, especially for adults who may suffer from partial cognitive impairment. In order to increase adherence for older adults with multiple chronic conditions, we use a mobile app called Pillsy. Pillsy, a Seattle-based company, provides pill-bottles that register data based on the patient's conditions, medication, and times that the pill bottle is opened/closed. This product, which Pillsy refers to as a "Smart Pill Container," tracks when a patient takes their pills and allows for a patient to set up a profile with information on their specific conditions and the corresponding pills they must take. This information can be shared with their family, medical health experts, caretakers, and others within the patient's specific circle of care. We plan to pair this with an Activity Learning app that will allow the Pillsy app and device to document and recognize the activities of the user over a period of time; this in turn allows for the building up of patterns based on what a user is predicted to be doing at a certain time. Knowing what a user is likely to do at certain points in an average day or average week allows for smarter prompting from the Pillsy app. Our goal for this app in the long term is to increase medication adherence amongst the elderly suffering from multiple chronic conditions, and we believe that a smart prompting system paired with a tool that directs info directly to the circle of care is the best route for achieving this.

52	**Using Amazon Echo as a Framework to Communicate Patient Results from CASAS Smart Homes**	52

Undergraduate Researcher: James Riggleman

Coauthors: Jackson Peven, Aaron Crandall

Home Institution, Major, Class Standing: University of Washington, Computer Science, Sophomore

Abstract:

CASAS smart homes, which monitor the activities of elderly populations, have provided large, reliable data samples over the past several years; the next step is finding a way to effectively present this data to nurses, healthcare professionals, and family members. Amazon Echo, a voice activated wireless speaker, fits well for this project because it is user friendly, making it an appealing option for users who want quick and simple updates about how their patients are doing. Using Echo, one can ask about a patient's current state of health and Echo will process and return a concise response to give an overview of the patient's condition across any time period. To implement this project, we will also design a prototypical data framework using RabbitMQ which will analyze sensor responses received from CASAS smart homes and prepare it to be used by potential clients (phones, websites, etc.) including Alexa. This processing framework will also serve as a basis for future projects such as smartphone integration, employing new data processing algorithms, and adding new types of sensors for expanded and improved monitoring. We predict that using Amazon Echo and our processing platform will make data more accessible and comprehensible, thus expanding our user base while making it easier for current caretakers to monitor patients.

53	Night Out Task	53

Undergraduate Researcher: Wesley Smith

Coauthors:

Home Institution, Major, Class Standing: Weber State, Computer Science, Junior

Abstract:

As technology continues to advance it makes it possible to determine whether a patient has any cognitive impairments based on how they perform their everyday activities. Using an android app we developed we were able to collect data in which a volunteer would perform a list of tasks in a controlled environment. A trained clinician observed the participant and entered the behavior into the app. At the end of each session the application summarized the results and gave the volunteer a score based on their performance. Using the data we collected, we used machine learning to find patterns which indicate issues with cognitive health. These patterns include variables such as time taken for each task, a volunteer's ability to multitask, the strategic order of tasks, efficiency of task completion, and accuracy of task completion. With this app we hope to be able assess an individual's mental health, and use technology to gather data in less controlled environments and search for correlations between the daily activities of patients and their score.

Group 7: Smart Environments (REU in Electrical Engineering and Computer Science)

54	Examining Perception of Unmanned Aerial Systems	54

Undergraduate Researcher: Kathryn Kresnye

Coauthors: Matthew Taylor, Leah Zulas

Home Institution, Major, Class Standing: Xavier University, Computer Science, Senior

Abstract:

The applications of Unmanned Aerial Systems (UAS) have been expanding in recent years due to improved technology and dropping prices. This technology has been applied to aid in medical fields, environmental protection, and most commonly, entertainment (e.g. photography, hobbyist). Even with the advancement of this technology in humanitarian and recreational disciplines, society's view may be biased by governmental use highlighted in media outlets. This study aims to better understand the perception of this technology through manipulating the terminology (e.g. UAS vs drone). This study also attempts to change the perceptions of participants using interventions online, and in-person interactions. The goals of the interventions is to improve the participants' overall views of UAS, and better understand which methods are most successful at this task. The results of this study sheds light on society's current relationship with UAS, and can guide future human-drone interactions to be more positive.

55	Top-k Event Discovery for Graph Streams	55

Undergraduate Researcher: Shayan Monadjemi

Coauthors: Mohammad Hossain Namaki, Yinghui Wu, Lawrence Holder

Home Institution, Major, Class Standing: University of Texas Dallas, Computer Science, Junior

Abstract:

Representing data and information in graphical models is a common practice in computer science. These graphs contain nodes that are connected by edges. The edge connection of any two nodes indicates a relationship between them. An abstract graph pattern of how these nodes are related is called an event pattern. Given such a data graph G that is continuously evolving over a time window T by adding/deleting edges, the top-k event pattern discovery problem is to extract and monitor the top-k most significant complex event patterns in G over T. In our study, we consider the top-k event discovery problem over a single window, and develop effective algorithms that incrementally maintain top-k event patterns when new updates occur. We perform case studies over an academic (citation) network and the Panama offshore company dataset. We show that the algorithm can identify meaningful top-k patterns in a timely fashion. We also demonstrate the application of the algorithm in many areas such as network security, social media analysis, and activity identification in smart environments.

56	Switching Algorithm for the Phasor Measurement Unit (PMU)	56

Undergraduate Researcher: Linh Nguyen

Coauthors: HyoJong Lee

Home Institution, Major, Class Standing: Washington State University, Computer Engineering, Senior

Abstract:

In this project, the switching algorithm was alternated and implemented into the Phasor Measurement Unit (PMU). Due to varying conditions of the power system, the switching algorithm helped in smartly determine and switch between phasor estimations regarding steady state and dynamic operating conditions. These conditions were detected using signal processing based on the energy theorem to determine the mean square error between two input signal periods. The main purpose was to provide a more precise and accurate estimation results for all conditions. The project involved design, characterization, and optimization of the switching algorithm, which was mainly performed and tested through Nation Instrument LabVIEW software. The results of this switching algorithm proves that it has great effects on helping the estimation process run smoother and a step closer to error-free. The NI Phasor Measurement Unit, used for this project, is located in Smart Grid Demonstration and Research Investigation Lab (SGDRIL) at Washington State University in Washington, U.S.

57	3D UWB Localization Based Infant Pain Assessment System in Incubators Using Dynamic Averaging Algorithm and Ranging	57

Undergraduate Researcher: Biniyam Obsu

Coauthors: Subhanshu Gupta

Home Institution, Major, Class Standing: Washington State University, Electrical Engineering, Senior

Abstract:

Pain is generally measured by patient self-report, normally via verbal communication. However, if the patient is a child or has limited ability to communicate self-report may not be a viable measurement. In addition, these self-report measures only relate to the maximum pain level experienced. Using real-time monitoring, in this paper we are proposing system that can recognize expression of analyzing mouth opening through high-resolution spatial sensors for accurate measurement.

With our proposed mode in this system, the tags are placed at the commissure of the mouth, while three anchors are placed at fixed locations on the incubator. By continuously measuring the time difference of the signal arriving at each anchor, exact positions of the tags in a 3D plane can be predicted. A dynamic averaging algorithm combined with two-way time message exchange is investigated and compared with a trilaterization scheme available on the commercial-off-the-shelf sensor.

58	GraphZip: Dictionary-based Compression for Graph Mining	58

Undergraduate Researcher: Charles Packer

Coauthors: Lawrence B. Holder

Home Institution, Major, Class Standing: University of California San Diego, Computer Science, Senior

Abstract:

A novel approach to finding interesting patterns in a graph is to find those patterns that best-compress the graph. More concretely, we can compress a graph *G* using a pattern *P* by replacing all instances of (subgraph) *P* in *G* with a new node representing *P*. The reduction in size of *G* is a measure of the compression afforded by a pattern *P*, and we want to find patterns that maximally compress a graph. This same concept shows up in data compression (e.g., zip/unzip) in that the compression method looks for recurring patterns or sequences in the data stream, builds a dictionary representing these patterns by shorter binary codes, and then stores the compressed data as just the codes and the dictionary. In the case of graphs, a side-effect of this process is that the pattern dictionary contains a set of subgraph patterns that compress well, and therefore represents an alternative approach for finding interesting (highly-compressing) patterns in a graph stream.

We propose a dictionary-based compression method for graph-based knowledge discovery: *GraphZip*. While several methods have already been developed for analyzing smaller graphs, large graphs such as real-world social networks stress the limitations of such methods due to their dynamic nature and the substantial number of nodes and connections involved. Qualitatively, we show that our system is able to retrieve both complex and insightful patterns from large (100k+ nodes) real-world graphs by utilizing graph streams. Quantitatively, we show that our system is able to successfully mine artificially-generated graphs with predefined (i.e., ground truth) patterns. In our experiments we also compare the theoretical and real-time performance between *GraphZip* and other state-of-the-art methods.

59	**Comparing artificial intelligence systems using visual-only input through ViZDoom**	59

Undergraduate Researcher: Christopher Pereyda

Coauthors: Larry Holder

Home Institution, Major, Class Standing: Whitworth University, Computer Science, Senior

Abstract:

With the continual increase in the development of Artificial Intelligence, it is often wondered if the system is genuinely intelligent. Though there are several well-known tests already in existence, they do not check every aspect of the system. With the creation of ViZDoom we now have a method for checking how well a system can play the game Doom, a challenging real-time first-person shooter game. ViZDoom creates an environment that allows us to test AI systems using the same visual-only input that a human would receive. Using this environment we test three different AI systems. The first will be a rule based system, in which we tell it what it should do when certain features occur. The second is a deep-learning method with the whole image as the input. It is trained until the system converges and produces acceptable performance. The third system is a continuation of the first. Instead of telling the system what to do, we train it to figure out what to do when certain features arise. We compare the performance of these three systems in terms of maximum reward and quickest finish time, in order to evaluate VizDoom's ability to assess the intelligence of such systems.

60	Randomized Local Search for Structured Prediction	60

Undergraduate Researcher: Vanessa Putnam

Coauthors: Janardhan Rao Doppa

Home Institution, Major, Class Standing: University of California Santa Cruz, Computer Science, Senior

Abstract:

Structured prediction problems arise in a number of application domains including natural language processing, computer vision, social networks, and smart environments. The goal of structured prediction problem is to map a given structured input to a structured output. A prototypical example is that of Part-of-Speech (POS) tagging, where the structured input corresponds to a sequence of words and the structured output corresponds to the POS tag sequence for the words. The main learning and prediction challenge in these problems is that there are huge number of possible structured outputs (e.g., many possible part of speech taggings for a sentence). A standard approach to structured prediction is to learn a cost function for scoring a potential output for each input. Given such a cost function and a new input, the output computation involves solving the so-called ``Argmin inference problem,'' which is to find the minimum cost output for the corresponding input. Unfortunately, exactly solving the Argmin inference problem is often intractable (computationally very hard) except for some special cases. In this work, motivated by some past successes of randomization in effectively solving combinatorial optimization problems, we explore “randomized local search” for learning and making predictions for structured prediction problems. This approach allows the use of expressive cost functions with negligible overhead, and is inherently anytime by nature. The speed and effectiveness of our approach depends critically on the quality of starting states employed for local search and the number of restarts. To improve the effectiveness, we sample the starting states from a learned probability distribution over local variables. Our preliminary experiments over sequence labeling tasks demonstrate the efficacy of our approach with intelligent sampling process. We also perform diagnostic analysis to understand the shortcomings of our approach.

61	Graphical User Interface for RepeatAnalyzer	61

Undergraduate Researcher: Jonathan Squibb

Coauthors: Assefaw Gebremedhin, Helen Catanese

Home Institution, Major, Class Standing: University of Illinois Chicago, Computer Science, Senior

Abstract:

This REU summer project aims to add a graphical user interface (GUI) to RepeatAnalyzer, a new software tool designed to track, manage, analyze, and catalog short-sequence repeats (SSRs) and genotypes. Short-sequence repeats occur in both eukaryotic and prokaryotic DNA. They are of interest as they can be used in genotyping, phylogenetic characterization and analysis of pathogenicity. One species where SSRs have proven useful for genotyping is Anaplasma marginale, a bacterial tick-borne pathogen of cattle. The development of a vaccine for this pathogen is challenging for researchers, among others because of the need for deeper understanding of strain variation and distribution. Cataloguing and tracking SSRs is also difficult as various groups of researchers are involved in the process of identifying the repeats. Furthermore, the cataloguing process can be susceptible to errors when done manually. RepeatAnalyzer was developed to address these needs using Anaplasma marginale as a model species. A variety of similar tools currently exist, however, they lack the analysis and visualization capabilities offered by RepeatAnalyzer. The addition of a GUI and further data visualization functionalities to the current version of RepeatAnalyzer will increase the usability of the tool and its overall impact on the field.

62	**Activity Recognition and User Identification Using a Wearable Stretch Sensor**	62

Undergraduate Researcher: Ryan Torelli

Coauthors: Gabriel V. de la Cruz, Shivam Goel, Ramin Fallahzadeh

Home Institution, Major, Class Standing: Washington State University, Computer Science, Senior

Abstract:

The ability to classify physical activity and associate activity with an individual provides context for many applications in pervasive computing. In order to recognize activity, spatial and temporal attributes of the individual, such as limb movement, must be known. The gold standard wearable technology for capturing motion is inertial sensor, which measures acceleration and angular velocity. An alternative to directly sensing motion is monitoring contraction and relaxation of muscle and inferring motion. In the present study, a sensor band worn about the leg monitored muscle contracture for the purpose of recognizing activity and identifying the user in comparison to inertial sensor. Twelve healthy participants wore stretch and inertial sensors while performing a protocol incorporating activities of daily living. Sensor data was segmented in non-overlapping windows, from which statistical and morphological features were extracted. Machine learning algorithms generated models for activity recognition or user identification by mapping features to labeled activity or user. The performance of models was tested, demonstrating that a single-node stretch sensor recognizes activity to within 10% of the gold standard inertial sensor and identifies users similarly.

63	Renaming Automatically Generated Java Code	63

Undergraduate Researcher: Timothy Vierow

Coauthors:

Home Institution, Major, Class Standing: Washington State University, Computer Science, Senior

Abstract:

Automatically generated code is used in many areas of programming, such as user interface (UI) development. By using tools that automatically generate code for UI elements, a programmer's job is made easier by giving them a template, of sorts, to work with rather than having to write all of the UI interaction code themselves. However, automatically generated code frequently uses ambiguous naming for elements. For example, the name for a generated button that is intended to start a search might be called "Button1". Without the programmer manually changing the names of the elements, the code can be very hard to understand. My project aimed to see if I could use natural language to rename the elements based on the context of what each element does. This would increase the readability of the source code. To do this I needed to find some recurring patterns in the declaration and/or use of the UI elements that would allow me to create a suitable name for the element. I started by converting a number of open source java projects into XML files and then querying the XML files to extract declaration statements. I then looked through some of these declaration statements to find some basic patterns. One pattern I found was that often, a string would be passed into the constructor of the element and the string would contain a word or phrase that would explain what the element was for. The string could then be ran through a natural language tagger and an improved suggested name could be built from the noun phrases and/or verbs.

Group 8: Mechanical and Materials Engineering, Chemical Engineering, Biological Systems Engineering, Electrical Engineering and Computer Science, Civil Engineering, Chemistry, and Bioengineering

64	**Processing and characterization of novel vinyl ester using methacrylated vanillyn alcohol as green reactive diluent**	64

Undergraduate Researcher: Dominick DeSimone

Coauthors: Vijay Kumar Thakur, Yuzhan Li, Mitchell Rock, Katherine Mireles, Michael R. Kessler

Home Institution, Major, Class Standing: Washington state university, Materials Science and Engineering, Senior

Abstract:

The automotive and other manufacturing industries are heavily dependent on fossil fuels as feedstocks. Seeing the rising environmental concerns and depletion of petroleum resources, many industries are looking for ways to replace petrochemical feedstock with renewable raw materials to make the final product more environmental and user friendly. Among various petrochemical based feedstock, styrene has been classified as a highly volatile organic compound that is used frequently in the automotive and other industries. One of the prominent use being as a reactive diluent in polymer matrices such as vinyl ester for the preparation of polymer composites. So, the objective of this project is to develop novel vinyl ester based polymers employing low-cost environmental friendly bio-based reactive diluents that decrease dependence on petroleum based diluents such as styrene. To accomplish this, in the current work we have used bio-based methacrylated vanillyl alcohol (MVA) as reactive diluent in vinyl ester resin. A series of novel vinyl ester polymers was prepared using the varying amount of methacrylated vanillyl alcohol (MVA) employing free-radical polymerization. The prepared polymer samples were thoroughly characterized using dynamic mechanical analysis (DMA), thermogravimetric analyses (TGA), and tensile tests. The new polymers were found to exhibit promising properties suitable for advanced composite applications.

65	**Investigation of the composition of aqueous phase thermochemical product using various methods of analytical chemistry.**	65

Undergraduate Researcher: Kristen Ford

Coauthors: Iva Tews

Home Institution, Major, Class Standing: Washington State University, Chemical Engineering, Senior

Abstract:

It is cost effective and environmentally imperative for society to reduce its dependence on fossil fuels as a sole source of transportation fuels. One alternative is production of bio-oil via thermochemical processes such as pyrolysis and hydrothermal liquefaction (HTL). Both processes use heat and pressure to cleave the chemical bonds causing material depolymerization. The resulting monomers can then be chemically reconstructed into hydrocarbons allowing for blending with, and partially replacing transportation fuels. Currently, algae and wood species are being researched as bio-oil feedstock due to their potential for high yields of oil. Additionally, carbon dioxide pollution decreases with biofuel production, because the CO2 is recycled back into biofuel crops in order to grow them. Most bio-oil or bio-crude products consists of two phases; an aqueous and an organic phase. The focus of this poster is to investigate the composition of the aqueous phase. Various methods of deductive chemistry such as the Folin–Ciocalteu method, GC/MS, LCMS and CHNO analysis will be used to identify and quantify the components of the aqueous phase product. Aqueous phase samples were obtained from wood pyrolysis, wood HTL as well as algae HTL processing.

66	PERKS: Power Electronics Refined Learning via affordable kit and Software tutor	66

Undergraduate Researcher: Jacob Greig-Prine

Coauthors: Kevin Toombs, Ali Mehrizi-Sani

Home Institution, Major, Class Standing: Washington State University, Electrical Engineering, Senior

Abstract:

Power electronics technologies are fundamental in the transmission and distribution of electric power. However, the software tools currently available for power electronics analysis are geared toward industry and do not provide sufficient feedback in teaching how to solve these circuits. An online tutor system is being designed in this project to scaffold problem solving for students by helping them create circuit diagrams, translate the diagrams into equations, and solve the resulting equations. For the first iteration, the tutor is limited to DC-DC converters consisting of a single resistor, capacitor, inductor, and voltage source. The tutor also allows for two single-pull-single-throw switches and two diodes. If an error in the circuit is found, the software guides students by providing constructive feedback describing the issue, cause, and suggested solution for the circuit diagram. The circuit diagram and equations are built using a drag and drop interface to reduce possible mistakes. After the correct equations are produced, the current and voltage waveforms obtained from the equations are displayed alongside the exact solution obtained through solving the circuit differential equations.

67	**New Evidence for the Site-Pairing Preference of Framework Aluminum in ZSM-5, from its Reaction with $Ga(CH_3)_3$**	67

Undergraduate Researcher: Kyle Groden

Coauthors: Susannah Scott, Jean-Sabin McEwen

Home Institution, Major, Class Standing: Washington State University, Chemical Engineering, Senior

Abstract:

ZSM-5 is a zeolite catalyst marked with great versatility in catalytic application as a results of its flexibility in cation incorporation. Due to this property, the structure of ZSM-5 has been under question for its ability to accept divalent cations, implying that the substituted Aluminum sites exist in paired configurations at specific locations within the zeolite structure. Trimethyl gallium was used to probe these sites, as the dimethyl gallium fragments that exist in these locations following impregnation were thought to bridge via the terminal methyl groups. Experimental extended x-ray absorption fine structure (EXAFS) spectroscopy data supported this bridging configuration due to the presence of potential Gallium-Gallium scattering signals. In an attempt to support the experimental findings, zeolite cluster models were created containing potential sites for aluminum pairings with dimethyl gallium fragments. Geometrical conformations were obtained from first principles using the Perdew-Burke-Ernzerhof (PBE) functional . The bridging was found unfavorable due to framework oxygen bonds dominating any possible methyl interactions. The existence of dimeric trimethyl gallium was deemed strongly unfavorable in the literature , so additional optimizations of a trimethyl gallium dimer were performed using PBE and revised PBE functions, while also including van der Waals interactions in the models , . Through these calculations, it appears that a trimethyl gallium dimer is indeed possible under vacuum conditions. Using this, alternative models were developed to potentially explain the Gallium-Gallium scattering path reported by the EXAFS.

68	Importance of Plan Curvature in Watershed Models	68

Undergraduate Researcher: Jared Ribail

Coauthors: Jan Boll, Mengqi Zhao

Home Institution, Major, Class Standing: Washington State University, Civil Engineering, Senior

Abstract:

A hillslope's hydrologic response to precipitation events is largely controlled by the topographic features of a given hillslope, specifically the profile and plan curvature. Understanding these properties is necessary to accurately model hydrologic characteristics such as total surface flow, subsurface lateral flow, location of runoff generation and drainage response. Many models simplify hillslope topography and ignore the curvature properties, and only seldom do they use alternate measures such as a topographic index or the hillslope width function. In this study, we evaluate the sensitivity of rainfall-runoff modelling to profile and plan curvature in two models. In the first model the Water Erosion Prediction Project (WEPP) model, hillslope simulations do not capture topographic features, and instead WEPP gives a representative width to the hillslope by use of a width function which divides the drainage area by the average flow path length. In the second model, A Soil Moisture Routing (SMR) model, a geographical information system (GIS) captures this curvature through a grid based analysis. Sensitivity to topographic features was tested for, three profile curvatures (convex, concave, straight) combined with three plan curvatures (diverging, converging, uniform) resulting in a total of nine hillslopes. Simulations of uniform plan curvature was assumed equivalent to WEPP hillslopes. Each hillslope was subjected to different rainfall events to detect threshold behavior for when topographic features cannot be ignored, and thus when it is not appropriate to use a model which uses a width function to model the hydrology of a region.

69	**Construction and Testing of a Modular Ion Mobility Spectrometry Cell with Faraday Plate or RIIN Detection**	69

Undergraduate Researcher: Carolyn Saba

Coauthors: Gabriela Manocchio, Brian Clowers, Eric Davis

Home Institution, Major, Class Standing: Azusa Pacific University, Chemistry, Senior

Abstract:

Ion mobility spectrometry (IMS) is an analytical technique employed in security screening, environmental monitoring, and military applications for the detection of explosives, narcotics and chemical warfare agents. Most IMS instruments are equipped with a Faraday plate for ion detection following IMS separation. In this work, an alternative ion detection mechanism known as radiative ion-ion neutralization (RIIN) is investigated. In RIIN, IMS-separated product ions are neutralized with ions of the opposite polarity. This neutralization results in electronically excited neutral products which subsequently release electromagnetic radiation. This light is detected using either a photomultiplier tube (PMT) or monochromator/charge-coupled device (CCD) and serves as the detected medium for the IMS experiment. The purpose of this project is to design a new IMS cell that takes advantage of RIIN as an ion transduction mechanism using a corona or electrospray needle to act as its mediator, and to construct an optical system that would allow light produced by RIIN to be detected by a CCD. An IMS cell was built for this purpose with a modular ion detector for either Faraday Plate or RIIN detection. This IMS was tested with a Faraday plate and a modernized gate controller using IMS standards di-tertbutyl peroxide (DtBP), dimethyl methylphosphonate (DMMP), lutidine, and methyl salicylate to confirm IMS separation. In addition, a mockup design of the RIIN optics was constructed in a dark room for optical alignment where the emission spectrum of nitrogen was observed. This lensing system determined specifications and guided the design of a fixed optical layout for the modular RIIN interface on the aforementioned IMS cell.

70	The Effect of Starvation on Bacterial Survivability in Sand and Evolution of Biofilms	70

Undergraduate Researcher: Chia-Ling Kang

Coauthors: Kyle Groden, Hassan Zbib, Somayeh Ramezanian, Nehal Abu-Lail

Home Institution, Major, Class Standing: Washington State University, Bioengineering, Senior

Abstract:

Formation of biofilms in soil environment offers the potential to sustainable solutions for many geotechnical problems such as soil erosion, soil contamination by chemical compounds including petroleum hydrocarbon and reduction of soil stability. However fundamental studies are needed to facilitate the design of upscale processes and overcome technical difficulties to perform field studies. The frequency and amount of nutrients needed to maintain cell growth and the effect of starvation on biofilm formation in soil by microorganisms are questions that need to be yet addressed. As such in this study, the growth kinetics of starved *Pseudomonas putida* and quantity of extracellular polymeric substances (EPS) formed by the bacteria are being examined over the course of 60 days. To start the experiment, *P. putida* were grown in 6-well plates filled with clean sand and fed regularly with mineral medium supplemented by 1g/L glucose as the carbon source for a week. After the first week, glucose will no longer be supplied to the bacteria in half of the wells and the mineral medium will only be replaced for the purpose of providing the bacteria with ample oxygen. Control plates constantly being provided nutrients will be maintained throughout the 60-day experiment. Colony forming Unit (CFU) counts will be used to record the growth kinetics of the bacteria. Extraction techniques will be used to isolate the EPS, followed by Lowry and Anthrone assays to analyze the protein and carbohydrate content, respectively. We anticipate a drop in biofilm growth within our 60-day experiment and alternation in protein and carbohydrate quantity of biofilm when the cells are starving. The results of this study can be used to determine the feasibility of biofilm applications in soil environment and also maximize their cost-effectiveness through the minimization of supplied nutrients.

71	**Escherichia coli Strains' growth and biofilm formation with respect to their antibiotics' resistance**	71

Undergraduate Researcher: Hassan Zbib

Coauthors: Ali Abdulmajeed, Samuel Uzoechi, Nehal Abu-Lail

Home Institution, Major, Class Standing: Washington State University, Material Science and Engineering, Junior

Abstract:

Escherichia coliare is a Gram-negative bacteria belonging to the bacterial family Enterobacteriaceae. They are responsible for a broad spectrum of diseases such as gastrointestinal tract infections and diarrhea. E. coli strains vary in their resistance to antibiotics. One of the common accepted resistance mechanisms to antibacterials is biofilm formation. Here, our goal was to characterize the ability of different strains of E.coli to grow and form biofilms. The strains used are characterized with respect to their multi-drug resistance to antibiotics. To quantify biofilm formation of E. coli.strains, a crystal-violet binding assay based on optical density at 600 nm was used. Eight bacterial isolates from different sources were allowed to form biofilms in wells of a 96 wells-microtiter plate. Isolates were stained with crystal violet which bonded total biofilm biomass and solubilized in 95% (v/v) ethanol for 15 minutes. Our results indicated that all isolates except one were able to form biofilms. Strains were divided into four categories according to their abilities to form biofilms. These are:(1) not a biofilm producer (0), (2) weak biofilm producer (+), (3) moderate biofilm producer (++) and (4) strong biofilm producer (+++).Statistical analysis did not show significant differences between two strong and two moderate biofilm producers (P > 0.05). However, significant differences between the three weak biofilm producer strains were observed (P < 0.05). The growth rates of the selected strains ranged from 0.018 m-1 to 0.023 m-1 and were not statistically different among isolates investigated. Finding correlations between biofilm formation and antibiotic resistance are ongoing.

72	**Observation of stochastic mechanical behavior in polycrystalline Nb during nanoindentation**	72

Undergraduate Researcher: Saul Moran

Coauthors: P.C. Wo, H.M. Zbib

Home Institution, Major, Class Standing: Washington State University, Material Science and Engineering, Senior

Abstract:

The demand for smaller, lighter, and more compact devices nowadays calls for an urgent need for a better understanding of the mechanical properties at the sub-micron length scale. The focus of this study was to observe any stochastic mechanical properties during nanoindentation of pure polycrystalline niobium (a body centered cubic material). In particular, correlations between the pop-in effect in the load-displacement curves during nanoindentation and the distance between the indent and a grain boundary are studied. The grain structures of an electro polished niobium foil were examined using an optical microscope, and electron backscattered diffraction (EBSD) in a scanning electron microscope. The grains in the as-given (not annealed) sample was found to be equiaxed and an average of 100 +/- 30 μm. Nanoindentation tests were performed at various distances along a selected grain boundary in order to study the influence of this grain boundary on the stochastic nature of nanoindentation behaviors.

73	**The effect of microstructure on the stochastic mechanical properties in polycrystalline Cu**	73

Undergraduate Researcher: Ben Schuessler

Coauthors: P.C. Wo, H.M. Zbib

Home Institution, Major, Class Standing: Washington State University, Materials Science and Engineering, Senior

Abstract:

Mechanical properties that are considered to be deterministic in the macro-scale, often appear to be stochastic in the sub-micron length scale during nanoindentation. The origin of such stochastic responses is not well understood. This work examines the potential influence of microstructure, in particular grain boundaries and grain orientations, on the stochastic nature of the sub-micron mechanical properties measured from a well-annealed high purity polycrystalline Cu sample. It was found that the pop-in load, displacement excursions at pop-in, hardness and reduced modulus all exhibited different extent of variations as a result of grain orientation. In addition, there appears to be a correlation between the distance of the indent measured from a grain boundary and the stochastic responses.

Group 9: Landscape Ecology and Ecosystem Dynamics of the Columbia River Basin: Integrating Aquatic and Terrestrial Perspectives – (REU Site at WSU Vancouver)

74	"Landscape Ecology and Ecosystem Dynamics of the Columbia River Basin: Integrating Aquatic and Terrestrial Perspectives" REU Site at WSU Vancouver	74

PI: Gretchen Rollwagen-Bollens

Coauthors: Stephen Bollens

Undergraduate Researchers: Michelle Devlaeminck, Aramee Diethelm, Kelsey Fenn, Francesca Frattaroli, Madeline Kelsch, Katarina Kubiniec, Rae Kuhlman, Jasmine Nguyen

Research Site: Washington State University Vancouver

Abstract:

The "Landscape Ecology and Ecosystem Dynamics of the Columbia River Basin" REU program at WSU Vancouver provides undergraduate researchers with in-depth exposure to landscape ecology and ecosystem dynamics in a way that explicitly contrasts terrestrial and aquatic systems. Our REU project pairs research faculty from the School of Environment with college students to conduct independent research projects over the 9-week summer session. We also take two field trips to sites on the eastern and western sides of the Columbia Basin within Washington state, and hold a weekly professional development seminar for all summer undergraduate researchers in Sciences on the Vancouver campus.

In Summer 2016, REU student research projects span the disciplines of biology, ecology, biogeochemistry, hydrology and ecological modeling to address both fundamental and applied questions at the community, ecosystem and landscape scale within the Columbia River Basin. We will present preliminary results from each project and specifically address how the roles of biotic vs. abiotic drivers of ecosystem processes are approached in terrestrial and aquatic systems.

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