2017 Graduate Research Colloquium

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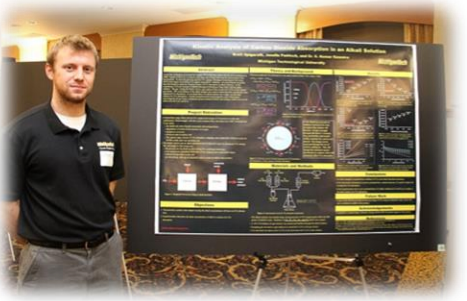
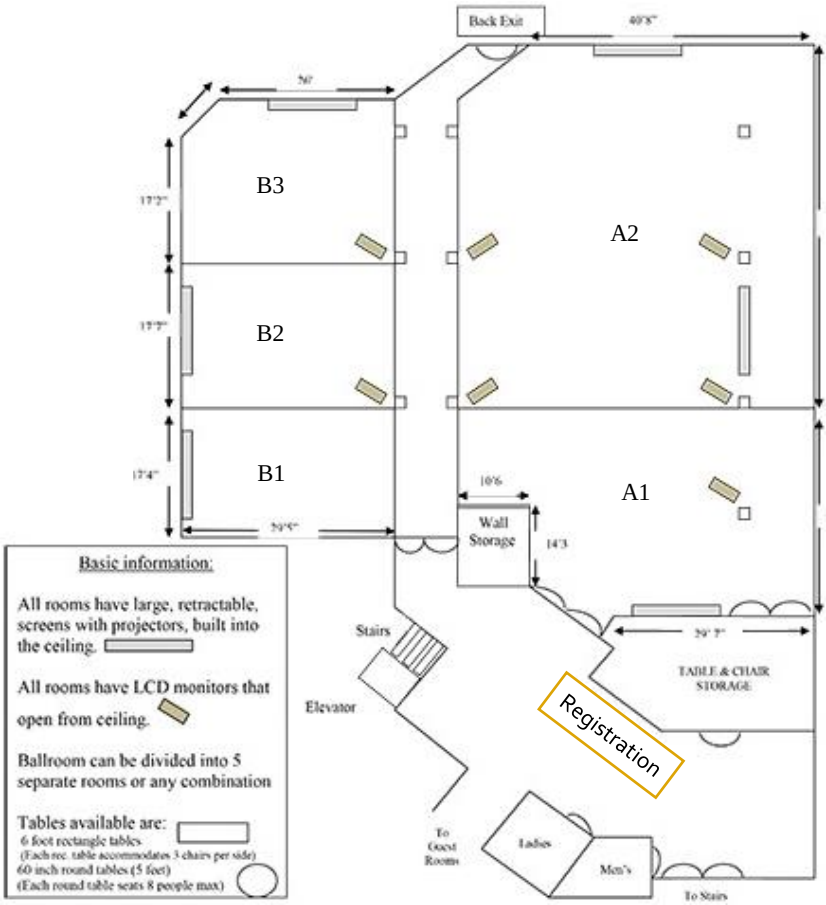


Contents

Ballroom Map



Schedule Summary

Wednesday, February 15, 2017

Time	Session	Location
8:05 AM – 9:05 AM	Poster Session Setup	A
8:05 AM – 9:05 AM	Author's Coffee	B2
9:05 AM – 12:05 PM	Poster Session	A
12:05 PM – 1:05 PM	Networking Social	A
1:05 PM – 2:05 PM	Novel Materials and Transport Phenomena Session A	B1
2:05 PM – 2:45 PM	Physical and Mathematical Sciences Session A	A2
2:05 PM – 3:05 PM	Environmental Studies and Protection Session A	B3
3:05 PM – 4:05 PM	Advances in Biology, Biochemistry, and Biomechanics	B1

Thursday, February 16, 2017

Time	Session	Location
8:05 AM -9:05 AM	Author's Coffee	A1
9:05 AM – 10:05 AM	Novel Materials and Transport Phenomena Session B	A2
9:05 AM – 10:05 AM	Physical and Mathematical Sciences Session B	B3
10:05 AM – 10:45 AM	Power and Energy Session A	B1
11:05 AM – 11:15 AM	Measurement Techniques and Analysis Methods	B3
11:05 AM – 12:05 PM	Advances in Modern Medicine Session A	A2
12:05 PM – 1:05 PM	Author's Coffee	A1
1:05 PM – 1:25 PM	Environmental Studies and Protection Session B	A2
1:05 PM – 1:45 PM	Physical and Mathematical Sciences Session C	B3
2:05 PM – 2:45 PM	Advances in Modern Medicine Session B	A2
2:05 PM – 3:05 PM	Power and Energy Session B	B1
3:05 PM – 3:45 PM	Arts and Humanities	B3

Poster Session Presentations

Wednesday February 15th, 2016
9:05 AM – 12:05 PM, MUB Ballroom A

Poster	Title	Presenter(s)
1	Synthesis of Oligodeoxynucleotides Containing Electrophilic Groups	Shahien Shahsavari
2	Investigation of MiR396-GRFs Module on Tomato Plant Development and productivity	Haiping Liu
3	Development of an Upper-Body Eccentric Arm Ergometer for Wheelchair Users	Matthew Kilgas
4	Engineering Oriented Microvessels on Aligned Extracellular Matrix Scaffold	Zichen Qian
5	Acidification with Acetic Acid Activates NMDAR and Increases Excitability of Central Nucleus of Amygdala Neurons with Axon Projecting to Rostral Ventrolateral Medulla	Andrew Chapp
6	Changes in Muscle Architecture in Individuals After ACL Injury	Zach Bennett
7	Food from the African Soul: On Rhetoric and Ideology in Contemporary Ghanaian Cookbooks	Nancy Henaku
8	Physical factors of accelerated warming of Lake Superior	Xinyu Ye
9	Sensitivity Analysis and Calibration of the SWAT Model for Rainfall-Runoff and Snow-Dominated Watersheds	Sara Mille
10	Water Quality Improvement in Drinking Water Storage Tanks Through Stagnation Reduction	Mohammad Alizadeh Fard
11	On The Banks of an Invisible Creek: How Trust Affects Citizen Participation and Engagement at the Nation's Largest Superfund Site	Kelley J.H. Christensen
12	Molecular and Chemical Characteristics of Long-range Transported Organic Aerosol at the Pico Mountain Observatory (PMO)	Simeon Schum
13	Investigating Silvicultural Systems for Promoting Tree Diversity in Managed Lake States Northern Hardwoods	Stefan Hupperts
14	Factors Affecting Fish Mercury Concentration in Inland Lakes	Mugdha Priyadarshini
15	Limb Asymmetry in Aerobic Capacity: A Comparison Between Individuals with and Without Major Knee Surgery	Brenna Sellman Kate Glodowski Zach Bennett Steve Elmer

Poster Session Presentations

Wednesday February 15th, 2016
9:05 AM – 12:05 PM, MUB Ballroom A

Poster	Title	Presenter(s)
16	Vortex Analysis of Intra-Aneurismal Flow in Cerebral Aneurysms	Kevin Sunderland
17	Moldable Nanocomposite Hydrogel as a Fit-To-Shape Tissue Sealant Based on Mussel-Inspired Chemistry	Yuan Liu
18	Self-Driving Cars: Future and Beyond	Deep Doshi
19	Facile Synthesis of Polyvinylpyrrolidone (PVP)-Capped Platinum (Pt) Nanocubes with Superior Peroxidase-Like Activity	Haihang Ye
20	The Synthesis and Mechanism Explorations of Extreme PH, Force-Sensitive Molecules	shulin wan
21	Mechanical Performance Prediction for Polymer-Polymer Composites - a Comparative Study Between Various Architectures	Muhammed R. Imam
22	Design of a Maneuverable and Adaptable Underwater Glider with Significant Payload Capacity	Brian Page
23	Extending Maneuverability of Internally Actuated Underwater Gliders	Saeedeh Ziaeefard
24	Molecular Characterization of Ambient and Laboratory Biomass Burning Influenced Aqueous Phase Secondary Organic Aerosol Utilizing Ultrahigh Resolution Mass Spectrometry	Matthew Brege
25	Minimum Time Control of Paralleled Boost Converters	Shishir Patel
26	Real Time Application of Battery State of Charge and State of Health Estimation	Khalid Khan
27	Experimental Investigation of Water Injection Techniques in Gasoline Direct Injection Engines	Niranjan Miganakallu
28	Implementation of Consensus Based Distributed Control in Power Systems Using PSCAD	Syed Ahmed Fuad

Oral Presentation Session Schedule

Wednesday February 15th

Novel Materials and Transport Phenomena Session A

MUB Ballroom B1, 1:05 – 2:05 PM

Time	Title	Name
1:05 PM	Stability and Electronic Properties of Amine Functionalized Boron Nitride Nanostructures	Kevin Waters
1:25 PM	Corrosion Characteristics Dictate the Long-Term Inflammatory Response And Biocompatibility of Degradable Zinc-Based Arterial Implants for Stent Applications	Roger Guillory
1:45 PM	Moldable nanocomposite hydrogel as a fit-to-shape tissue sealant based on mussel-inspired chemistry	Yuan Liu

Physical and Mathematical Sciences Session A

MUB Ballroom A2, 2:05 – 2:45 PM

Time	Title	Name
2:05 PM	Investigating Large Galactic Gamma-ray Structures with the HAWC Observatory	Hugo Ayala
2:25 PM	Stacking Analysis of Binary Systems with HAWC	Chad Brisbois

Environmental Studies and Protection Session A

MUB Ballroom B3, 2:05 – 3:05 PM

Time	Title	Name
2:05 PM	Analytical Modeling of Krauklis Waves in a Thin Hydraulic Fracture	Isa Ali
2:25 PM	Afforested Plantations Alter Ecosystem Services in pampas Grasslands in Argentina	Colin Phifer
2:45 PM	The Impact of Coastal Hydrodynamics on Local Ecosystem in the Lake Ontario Nearshore	Chenfu Huang

Advances in Biology, Biochemistry, and Biomechanics

MUB Ballroom B1, 3:05 – 4:05 PM

Time	Title	Name
3:05 PM	Investigation of MiR396-GRFs Module on Tomato Plant Development and productivity	Haiping Liu
3:25 PM	Characterization of Genic Microsatellite Markers (EST-SSRs) in the Endangered Tree *Quercus georgiana.*	Priyanka Kadav
3:45 PM	Characterization of a Novel Cytotoxic Hemolysin	Christina Welch

Oral Presentation Session Schedule

Thursday February 16th

Novel Materials and Transport Phenomena Session B

MUB Ballroom A2, 9:05 – 10:05 AM

Time	Title	Name
9:05 AM	Driving Selflessly into new age: Smart Cars	Deep Doshi
9:25 AM	The Synthesis and Mechanism Explorations of Extreme PH, Force-Sensitive Molecules	Shulin Wan
9:45 AM	A First Principles Study of Tunnel Magnetoresistance in Carbon Nanotube Junction	Meghnath Jaishi

Physical and Mathematical Sciences Session B

MUB Ballroom B3, 9:05 AM –10:05 AM

Time	Title	Name
9:05 AM	Design of a maneuverable and adaptable underwater glider with significant payload capacity	Brian Page
9:25 AM	Extending Maneuverability of Internally Actuated Underwater Gliders	Saeedeh Ziaeefard
9:45 AM	Computationally efficient density estimation over non-stationary high-dimensional data streams	Aref Majdara

Power and Energy Session A

MUB Ballroom B1, 10:05 AM –10:45 AM

Time	Title	Name
10:05 AM	Real Time Application of Battery State of Charge and State of Health Estimation	Khalid Khan
10:25 AM	Implementation of Consensus Based Distributed Control in Power Systems Using PSCAD	Syed Ahmed Fuad

Advances in Modern Medicine Session A

MUB Ballroom A2, 11:05 PM –12:05 PM

Time	Title	Name
11:05 AM	Conductive Coaxial Nanofiber Scaffolds for Neural Tissue Engineering	Rachel Martin
11:25 AM	Assessing the Immunogenicity of Potential Zika virus B cell Epitopes on Phage Virus-like Particles	Rupsa Basu
11:45 AM	MS2 Bacteriophage VLPs Displaying Multiple HPV L2 Epitopes Show Protective Antibody Responses against three HPV Types	Lukai Zhai

Oral Presentation Session Schedule

Measurement Techniques and Analysis Methods

MUB Ballroom B3, 11:05 AM –A1:15 AM

Time	Title	Name
11:05 AM	Vortex Analysis of Intra-Aneurismal Flow in Cerebral Aneurysms	Kevin Sunderland

Environmental Studies and Protection Session B

MUB Ballroom A2, 1:05 PM –1:45 PM

Time	Title	Name
1:05 PM	Physical factors of accelerated warming of Lake Superior	Xinyu Ye
1:25 PM	Water quality improvement in drinking water storage tanks through stagnation reduction	Mohammad Alizadeh Fard

Physical and Mathematical Sciences Session C

MUB Ballroom B3, 1:05 PM – 2:05 PM

Time	Title	Name
1:05 PM	What Time Is Sunrise? Revisiting the Refraction Component of Sunrise/set Prediction Models	Teresa Wilson
1:25 PM	Delay Efficient RSU Placement Algorithm for VANET Safety Applications	Ali Jalooli
1:45 PM	Adsorption and Diffusion Mechanisms of C1-C4 Hydrocarbon Molecules in MOF-74-Mg/Zn: A Quantum Chemical study on Selective Gas Separation Applications in Petroleum Refining Industries	Gemechis Degaga

Advances in Modern Medicine Session B

MUB Ballroom A2, 2:05 –1:45 PM

Time	Title	Name
2:05 PM	Engineering Oriented Microvessels on Aligned Extracellular Matrix Scaffold	Zichen Qian
2:25 PM	Acidification with Acetic Acid Activates NMDAR and Increases Excitability of Central Nucleus of Amygdala Neurons with Axon Projecting to Rostral Ventrolateral Medulla	Andrew Chapp

Oral Presentation Session Schedule

Power and Energy Session A

MUB Ballroom B1, 2:05 PM – 3:05 PM

Time	Title	Name
2:05 PM	Performance Analysis of Stall Controlled Variable Speed Wind Turbines Under Gust Loading Conditions	Sara Jalal
2:25 PM	Experimental Investigation of Water Injection Techniques in Gasoline Direct Injection Engines	Niranjan Miganakallu
2:45 PM	Aeroelastic Study of the Dynamic Wind Turbine Response to Rapid Pitch-Control Actions	Muraleekrishnan Menon

Arts and Humanities

MUB Ballroom B3, 3:05 PM –3:45 PM

Time	Title	Name
3:05 PM	Using Critical Discourse Analysis to Understand Power, Hegemony, and Blame in the Stanford Rape Case	Sara Potter
3:25 PM	Food from the African Soul: On Rhetoric and Ideology in Contemporary Ghanaian Cookbooks	Nancy Henaku

Poster Abstracts

Advances in Biology, Biochemistry and Biomechanics

Synthesis of Oligodeoxynucleotides Containing Electrophilic Groups

Shahien Shahsavari, Xi Lin, Jinsen Chen, Nathanael Green, Deepti Goyal, Shiyue Fang
1. Department of Chemistry, Michigan Tech, Houghton, MI

Oligodeoxynucleotides (ODNs) containing electrophilic groups are useful in many studies including antisense drug development and DNA/protein interaction. Due to the use of strong nucleophiles for cleavage and deprotection, traditional ODN synthesis methods are not suitable for their preparation. To solve this problem, a new ODN synthesis technology using the 1,3-dithiane-2-yl-methoxycarbonyl (Dmoc) function as protecting groups and linker has been developed. The Dmoc function is stable under all ODN synthesis conditions using the phosphoramidite chemistry. Upon oxidation of the sulfides in them, because of the drastically increased acidity of H-2, the groups and linker are readily cleaved under nearly non-nucleophilic conditions. Five ODNs including one with a thioester group and another with an α-chloroamide function were successfully synthesized using the strategy. It is predicted that the technique could be adaptable for the synthesis of ODNs containing other electrophiles.

Investigation of Mir396-Grfs Module on Tomato Plant Development and Productivity

Haiping Liu, Guiliang Tang
1. Department of Biological Sciences, Michigan Tech, Houghton, MI

MiR396 is highly conserved among plant species and targets growth-regulating factors (GRFs) which are plant-specific transcription factors. According to PlantTFDB (plant transcription factor database), there are 13 GRFs in tomato, and 9 of them are mediated by miR396 from computational prediction. Blocking miR396 produces larger organs all over the plant. We applied short tandem target mimic (STTM) to down-regulate miR396 and resulted in larger plant stature, including longer hypocotyl, bigger leaves, flowers and fruits. These observations are highly correlated with crop productivity. Additionally, high-throughput RNA-sequencing was performed to detect transcriptome changes with the down-regulation of miR396. Five of the predicted GRFs were concomitantly increased in their expression, which contributed to the higher accumulation of two cell cycle associated genes, CyclinD3;3 and Cyclin B2. Another typical phenotype of miR396 down-regulation is shoot apical dominance which might be resulted from dis-regulation of Auxin-signaling pathways. Shoot apical dominance was accompanied with less axillary buds outgrowth and led to lower fruit number of each plant. With the information from RNA-seq results, fungi-resistance essay will also be performed in the near future. Our studies agree with the conserved functions of miR396 among plant species, and our findings provide important references on improving this crop productivity.

Development of an Upper-Body Eccentric Arm Ergometer for Wheelchair Users

Matthew A. Kilgas[1], Jennifer L. Dannenbring[1,2], Lydia M. Lytle[1,2], Michael C. Morley[3], Steven J. Elmer[1,2]
1. Department of Kinesiology and Integrate Physiology, Michigan Tech, Houghton, MI
2. Department of Physical Therapy, Central Michigan University, Mount Pleasant, MI
3. Innovation and Industry Engagement, Michigan Tech, Houghton, MI

Engaging in physical activity is a top priority for wheelchair users. Two barriers

negatively impact wheelchair user's ability to exercise. First, poor fitness levels make it difficult to perform challenging upper-body movements designed to enhance strength and mobility. Second, not all exercise devices are usable for wheelchair users (i.e., wheelchair accessible, adjustable, safe, and enjoyable). To circumvent these issues, we designed a wheelchair accessible motorized eccentric arm ergometer (RENEW-U) that provides a high-intensity workout for upper-body muscles without over taxing the heart. PURPOSE: To establish RENEW-U as a metabolically efficient and useable exercise for wheelchair users and to explore the commercial landscape of this device. METHODS: Part I-Five individuals with spinal cord injury (T7-L1), performed 5min trials of: traditional concentric arm cycling and RENEW-U arm cycling at the same VO2. Perceived muscle soreness and liking of RENEW-U were assessed. Part II-Our team participated in the NSF I-Corps program which trains scientists and engineers to develop entrepreneurship skills that will lead to commercialization of new technologies. Specifically, we were tasked with conducting 100 interviews and participated in weekly webinars to learn about customers, partners, pricing, and revenue models. RESULTS: Part I-Power production was 3x greater for RENEW-U than traditional arm cycling (89±40 vs. 28±11 W, p=0.01) at similar cardiorespiratory demand. Participants could safely perform RENEW-U and reported they enjoyed this modality. Part II-We interviewed 20 wheelchair users (sedentary individuals to Olympic athletes), 19 physical therapists, 27 gym owners, 12 equipment manufacturers, and 27 others. Customer discovery revealed limited motivation to buy, and a small market. CONCLUSION: RENEW-U offers a metabolically efficient and enjoyable exercise and could be used in clinical settings to improve upper-body strength and functional. The commercial impact of RENEW-U was limited and we reached a "No-Go" decision for proceeding to scaling a business for our technology.

Advances in Modern Medicine

Engineering Oriented Microvessels on Aligned Extracellular Matrix Scaffold

Zichen Qian, Avik Ghosh, Wenkai Jia, Qi Xing, Feng Zhao*
1. Department of Biomedical Engineering, Michigan Tech, Houghton, MI

Creating aligned microvessels on tissue engineered scaffolds can provide natural inlets/outlets for perfusion and meet the functional requirement of certain tissue types such as cardiac tissues and nerves. Pre-vascularized naturally derived extracellular matrix (ECM) scaffold holds great potential in creating aligned three-dimensional (3D) pre-vascularized tissues when layered or combined with other biomaterials. The objective of this study was to demonstrate that aligned pre-vascularized ECM could be created by seeding human mesenchymal stem cells (hMSCs) on aligned ECM nanofibers to facilitate the oriented vasculature formation of endothelial cells (ECs). The mechanism behind vessel alignment was investigated by examining the microvessel morphology, angiogenic growth factors and cell adhesion protein secretion, as well as the basement membrane remodeling related matrix metalloproteinase (MMP) expression. Results have shown that aligned ECM nanofibers could guide the orientation of microvascular networks and promote microvessel formation with the aid of hMSCs. hMSCs and ECs co-culture released more angiogenic growth factors on aligned scaffolds during co-culture. More focal adhesion genes were expressed in the aligned scaffolds during the microvessel formation. The MMP-2 was activated earlier in aligned scaffolds than randomly organized scaffolds during the microvessel formation, indicating that the remodeling of basement membrane of ECs started earlier in aligned scaffolds. The aligned nanofibrous ECM scaffold with oriented microvessels holds great potential in biofabrication of 3D aligned functional tissues including cardiac tissues, skeletal muscles, and neural tissues.

Acidification with Acetic Acid Activates NMDAR and Increases Excitability of Central Nucleus of Amygdala Neurons with Axon Projecting to Rostral Ventrolateral Medulla

A. Chapp,1, K. Driscoll,1, J. Behnke,1, Z. Shan,1, QH. Chen,1
1. Department of Kinesiology and Integrative Physiology, Michigan Tech, Houghton, MI

We have previously demonstrated that bath application of acetate caused a dose dependent increase in the in vitro excitability of CeA neurons with axon projecting to rostral ventrolateral medulla (CeA-RVLM). We hypothesized that intraneuronal acidification due to acetate may be a contributing factor. In cultured neurons incubated with a pH sensitive probe, increases in bath application of acetate (2, 7.5 and 37.5 mM) significantly ($p < 0.05$) increased the corrected fluorescence intensity of neurons compared to control, indicative of acidification. Blockade of NMDAR with memantine abolished the acetate induced increase in cytosolic calcium, but had no effect on acidification. Next, the role of intraneuronal acidification with acetic acid was investigated under brain slice preparation. Specifically, we compared the action potential firing rate, depolarizing input resistance (R-input), and voltage threshold (Vt) for firing action potentials between control intracellular recording solution (pH = 7.35) and 7.5 mM acetic acid loaded intracellular recording solution (pH = 5.20). In current-clamp recordings, graded current injections evoked graded increases in discharge frequency among neurons from both groups. Maximum discharge evoked by +250 pA current injection in the acetic acid loaded (pH = 5.20) group was 31 ± 4 Hz (n=8), which was significantly greater ($p < 0.05$) than that of control group (pH = 7.35, 19 ± 1 Hz, n=7). NMDAR blocker had no effect on maximum firing rate +250 pA with intracellular loaded acetic acid. However, acetic acid and NMDAR block did significantly ($p < 0.05$) attenuate the gain of the current stimulus response compared to acetic acid alone. Intraneuronal acidification with acetic acid significantly ($p < 0.05$) increased R-input of CeA-RVLM neurons, and caused a hyperpolarizing shift in Vt (-49.28 ± 1.37 mV) compared to control neurons (-43.83 ± 1.76 mV). This data suggests that pH has profound effects on NMDAR and neuronal excitability.

Changes in Muscle Architecture in Individuals After ACL Injury

Zach Bennett[1,2], Kate Glodowski[1,2], Brenna Sellman[1,2], Steven Elmer[1,2],
1. Department of Kinesiology and Integrative Physiology, Michigan Tech, Houghton, MI
2. Doctoral Program in Physical Therapy, Central Michigan University, Mount Pleasant, MI

Muscle architecture, the thickness of a muscle, pennation angle, and length of fascicles, determines the functionality of a muscle. The effects of disuse include a decrease in muscle thickness and decrease in fascicle length, which result in reductions in maximum shortening velocity and maximum power. The long-term effects of an ACL injury on muscle architecture are not well established. The purpose of this study was to examine changes in muscle architecture following ACL injury and compare to healthy controls. We hypothesized that individuals who completed an ACL rehabilitation program would still exhibit reduced muscle thickness and fascicle lengths in the injured limb. Three individuals who had previously had an ACL injury and completed a rehabilitation program (4.5 years post-surgery), and three healthy controls participated in this study. Diagnostic ultrasound was used to assess the thickness of the rectus femoris, and thickness and pennation angle of the vastus lateralis. With these two measurements for the vastus lateralis, we were able to estimate vastus lateralis fascicle length. Healthy controls exhibited a 2% difference in the vastus lateralis thickness and a 1% difference in the rectus femoris thickness, indicating that any limb asymmetry was minimal. ACL individuals exhibited a 13% difference in the vastus lateralis thickness indicating that the vastus lateralis of the injured limb was smaller. ACL individuals had a 14% difference in the rectus femoris thickness, indicating that the

rectus femoris of the injured limb was larger than in the uninjured limb. Further in the ACL group, vastus lateralis fascicle lengths were 13% shorter in the injured leg, whereas in the control group fascicle lengths were very similar between right and left sides (2%). Shorter fascicle lengths indicate less sarcomeres in series, which factor into the muscle's ability to shorten and generate maximum power. This limb asymmetry observed years after ACL injury places these individuals at greater risk for re-injury, and also requires refinement of rehabilitation protocols for individuals after an ACL repair.

Arts and Humanities

Food from the African Soul: On Rhetoric and Ideology in Contemporary Ghanaian Cookbooks

Nancy Henaku
1. Department of Humanities, Michigan Tech, Houghton, MI

Technical documents are often interpreted as functional texts whose social, cultural and political dimensions could be ignored. Miller (1979 [2004]), however, argues that such a view presupposes a "window pane theory of language" influenced by a positivist epistemology that considers rhetoric as irrelevant to technical and scientific communication" and further suggests a communalist and "fragrantly rhetorical" approach to technical writing-- one that considers technical writing as a kind of enculturation (52). Following Miller's comment, this paper examines the rhetoric of Ghanaian cookbooks by focusing particularly on the strategies employed by the rhetors of these texts in envisioning a purpose, constructing an audience, constructing themselves as rhetors and projecting individual as well as communal identities. The discussion is theoretically underpinned by Miller's (1986 & 2015) notion of genre as social action and employs a mixed methods approach that combines concepts from rhetoric, semiotics and postcolonial studies. The paper will ultimately argue that the rhetoric of contemporary Ghanaian cookbooks are inherently contradictory in that they construct Ghana as an imagined community while targeting the West as its audience even as it essentializes, commodifies and exoticizes Ghanaian (African) cultures. Through this analysis of the intersection between rhetoric and ideology in Ghanaian cookbooks, this paper opens up unique cultural perspectives that may be significant for discussions in intercultural technical communication.

Environmental Studies and Protection

Physical factors of accelerated warming of Lake Superior

Xinyu Ye, Pengfei Xue
1. Department of Civil and Environmental Engineering, Michigan Tech, Houghton, MI

The climate change induced lake warming in high latitude regions has recently received extensive research and public attention. Due to limited data coverage, particularly during the harsh wintertime, how to assess and quantify the lake warming remains an open question. Using a 3-D circulation model driven by Climate Forecast System Reanalysis (CFSR) forcing, the physical factors of accelerated warming of Lake Superior are investigated with different process-oriented numerical experiments. The variation of the water mixing strength, the ice albedo feedback, and the ice insulation effect, play critical roles in controlling heat content and heat distribution in the lake by altering the structure of thermocline and the air-water heat flux exchange.

Sensitivity Analysis and Calibration of the SWAT Model for Rainfall-Runoff and Snow-Dominated Watersheds

Sara G. Mille[1] Veronica L. Webster[1]
1. Department of Civil and Environmental Engineering, Michigan Tech, Houghton, MI

The soil and Water Assessment Tool (SWAT) model is a widely used hydrological model for predicting impacts of land management practices on water, sediment, and agricultural chemical yields. This study focuses on the sensitivity analysis (SA) process which is an important step in identifying parameters relevant to stream flow generation before proceeding to the calibration process. Two watersheds, one an agricultural rainfall-runoff dominated watershed and the other a forested snow-dominated watershed, were studied. SA can produce different results/parameters in accordance with the implemented objective function and calibration techniques. The objective functions used as illustration in this study are: the Nash-Sutcliffe Efficiency (NSE), Coefficient of Determination (R2), Slope times R2 (bR2), and Percent Bias (PBIAS). Results show, SCS curve number (CN2) and snow fall temperature (SFTMP) were identified as the top sensitive parameters for both watersheds, and snowmelt temperature (SMTMP) for the snow-dominated watershed; however, ranks of sensitivity vary among the objective functions used. Preliminary results from the SA also show, NSE and PBIAS are biased towards high flows, 19% versus 190% relative error (RE) for high and low flows respectively. This implies parameters identified using these two objective functions tend to affect high flows than low flows. On the other hand, RE found using R2 and bR2 are relatively balanced across all flow magnitudes. This study also tested two calibration approaches for the snow-dominated watershed. Approach 1: SA of snow and hydrological parameters all together and then calibration. Approach 2: SA and "light" calibration of snow parameters separately, then followed by SA of hydrological parameters, and final calibration using the identified parameters. Results show a significant improvement in the performance of flow output in the latter case: NSE of 0.35 to 0.55.

Water Quality Improvement in Drinking Water Storage Tanks Through Stagnation Reduction

Mohammad Alizadeh Fard[1], Brian Barkdoll[1]
1. Department of Civil and Environmental Engineering, Michigan Tech, Houghton, MI

Poor mixing in water storage tanks can cause stagnation that could pose negative public health effects. To eliminate stagnant zones in a cylindrical water storage tank, this study investigated the feasibility of a novel internal piping configuration consisting of a sprinkler-type inlet piping that distributed the incoming flow evenly across the water surface and a corresponding upside-down sprinkler draining configuration at the tank bottom. Experiments were performed using acoustic Doppler velocimeter (ADV) and electrical conductivity (EC) measurements. Various stagnation metrics, like the time for the water to be well-mixed, and water particle velocity and direction, were employed for each configuration. Inlet/outlet convergence time is defined as a simple indicator, in which the lower the value, the higher the risk of short-circuiting. In the next step, experiments were performed with a temperature difference between the tank and the inflow due to density-driven flows. Results indicated that the novel piping resulted in parallel downward streamlines that eliminated most of the stagnation zones in the tank.

On the Banks of an Invisible Creek: How Trust Affects Citizen Participation and Engagement at the Nation's Largest Superfund Site

Kelley J.H. Christensen
1. Department of Social Sciences, Michigan Tech, Houghton, MI

This study of citizen participation and engagement in part of the nation's largest Superfund site — Butte, Montana — utilizes a narrative policy framework methodology with special attention paid to causal mechanisms underlying narratives. Citizen participation in large-scale environmental cleanup decisions is directly related to questions of environmental justice and participatory democracy. This paper analyzes content from several Montana news media sources, public hearing documents, and coalition websites to ask several questions. The paper seeks to address whether policy narratives led to renewed agenda building concerning previous Superfund cleanup discussions that have been considered foregone conclusions. The paper discusses how the narratives of the coalitions identified by this paper encourage public participation. Results indicate that a citizens coalition group has been successful in recently changing outcomes in the decision-making process. This study contributes to the Narrative Policy Framework by questioning the use of causal mechanisms within the framework, and arguing the importance of causal mechanisms in narrative formation, and by demonstrating the power of policy narratives influence policies of environmentally just Superfund cleanup.

Molecular and Chemical Characteristics of Long-range Transported Organic Aerosol at the Pico Mountain Observatory (PMO)

Simeon Schum[1], Bo Zhang[2], Katja Dzepina[3], Lynn Mazzoleni[1]
1. Department of Chemistry, Michigan Tech, Houghton, MI
2. National Institute of Aerospace, Hampton, VA
3. Department of Biotechnology, University of Rijeka, Rijeka, Croatia

Ultrahigh resolution mass spectrometry was used to determine the molecular formula characteristics of long-range transported aerosol collected at the Pico Mountain Observatory (2225 m above sea level) in the Azores Archipelago. Three samples, June 27, 2013, July 5, 2014, and June 20, 2015 were studied in detail. Two were primarily transported in the free troposphere while the other one was primarily transported through the boundary layer and then lofted to the site, based on FLEXPART back trajectory analysis. The aerosol samples primarily transported in the free troposphere were found to have lower oxygen-to-carbon (O/C) ratios (0.46-0.47) than the sample primarily transported within the boundary layer (0.55). It was also found that many of the molecular formulas assigned to the different samples were common to one or both of the other samples. This is especially prevalent in CHO (carbon, hydrogen, and oxygen only) molecular formulas where 85-98% in any sample were also present in at least one other sample. When comparing the observations from this study to analyses of other aerosol samples, cloud water, and Suwannee River Fulvic Acid (SRFA) it was found that more of the remote long-range transported aerosol species were common with SRFA (37.9-49.5%) than continental cloud water (27.7-33.1%). These observations are consistent with previous observations and provide additional information about the characteristics of free tropospheric organic aerosol.

Investigating Silvicultural Systems for Promoting Tree Diversity in Managed Lake States Northern Hardwoods

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Uneven-aged management using single-tree-selection provides a regular supply of timber and retains forest cover in the long-term while regenerating shade-tolerant species. These advantages have led to its widespread application in northern hardwood forests of the Lake States. Nevertheless, concurrent declines in tree species diversity have been observed, especially of mid-tolerant species, such as yellow birch (*Betula alleghaniensis*). It has been suggested that implementing a greater variety of silvicultural techniques in these forests, beyond single-tree-selection, may increase species diversity due to higher structural and spatial heterogeneity – important traits of sustainable forest ecosystems. The objective of this research is to investigate the response of northern hardwood stands to a variety of even- and two-aged management practices. Specifically, six treatments will be implemented: 1) uneven-aged management control; 2) shelterwood with high canopy retention; 3) shelterwood with low canopy retention; 4) irregular shelterwood with high canopy retention; 5) irregular shelterwood with low canopy retention; and 6) patch clear-cut. Seedling survival, plant community structure, and microsite conditions will be assessed before and after treatment application. We anticipate shelterwood and patch clear-cut treatments to create more heterogeneous microsite conditions than the current single-tree-selection management, consequently influencing plant community structure and seedling survival. This research will build upon our conceptual framework of successional dynamics in managed forests. Insights from this research will be used to design techniques aimed at increasing landscape heterogeneity in northern hardwood forests of the Lake States.

Factors Affecting Fish Mercury Concentration in Inland Lakes

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Mercury pollution is an environmental problem that adversely affects ecosystems and human health. Human activities like fossil fuel consumption, waste incineration and mining are responsible for Mercury contamination in the Great Lakes region. Mercury in the form of methyl mercury tends to bioaccumulate in the aquatic ecosystem, thereby affecting the fish, the fish-eating wildlife and humans. Bioaccumulation of methyl mercury may be affected by a wide variety of factors such as watershed area, organic carbon contents of sediments, pH, dissolved oxygen, food chain length, temperature, land cover characteristics, and others. To understand the effects of environmental factors on methyl mercury concentration in fishes, a study was conducted on the walleye in the inland lakes in the Upper Peninsula. Of the 74 lakes for which data were available, 69 had fish mercury concentrations above the values recommended for unlimited fish consumption. Multivariate statistical analyses were used to identify the parameters that affect the concentration of methyl mercury in walleye. Our results show that fish methyl mercury concentrations are best predicted by pH, maximum lake depth, and watershed area: lake area. While further investigation is warranted, this analysis provides a means to predict the lakes that are safest for fish consumption.

Human Impact and Sustainability

Limb Asymmetry in Aerobic Capacity: A Comparison Between Individuals with and Without Major Knee Surgery

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Anterior cruciate ligament is the most common ligamentous knee injury and participation in an intensive rehabilitation program is imperative for recovery. While restoration of muscle size and strength is critical, most activities of daily of living, including walking and stairclimbing, are submaximal in nature and thus rely on the aerobic capacity of the leg muscles. The extent to which a traumatic knee injury alters the aerobic capacity of leg muscles is not well documented. Our purpose was to evaluate differences in one-legged aerobic capacity (VO2peak) of the affected and unaffected limbs in individuals that had previously had major knee surgery and compare to healthy controls. We hypothesized that individuals that have had a previous knee surgery (KNEE) would exhibit greater limb asymmetry in VO2peak than healthy controls (CON). Participants (n=2 KNEE, 4.5 years post-surgery; n=2 CON) performed a continuous one-legged cycling task until exhaustion on a counterweighted cycle ergometer. Oxygen consumption, heart rate, and rating of perceived exertion were recorded. Limb asymmetry index (AI) was calculated as (unaffected limb VO2peak – affected limb VO2peak)/(maximum right + left VO2peak). Limb asymmetry in VO2peak was 11.9% (0.33 L/min) for the KNEE group and 5.7% (0.05 L/min) for the CON group. This pilot data may suggest changes to rehabilitation protocols to include involvement of exercises that improve aerobic capacity in order to provide safer outcomes for individuals with major knee injuries and surgeries. Since the hip extensor muscles are involved during cycling and could possibly compensate for impaired knee extensor function, future studies that utilize an endurance task that isolates the quadriceps might show even greater limb asymmetry in VO2peak.

Measurement Techniques and Analysis Methods

Vortex Analysis of Intra-Aneurismal Flow in Cerebral Aneurysms

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Intracranial aneurysms (IAs) are thinning spots (ballooning) of cerebral arteries. Affecting ~3% of the population, IAs cause neurological damage or death in the event of IA rupture. Currently, morphological parameters of IAs, and hemodynamic stressors along the IA wall are the basis for clinical prediction of IA rupture. These metrics help dictate clinical intervention, yet predictions vary in accuracy. This initial study aims to develop an alternative analysis method by measuring structure of IA swirling flow patterns (vortexes) across the cardiac cycle, to quantify temporal stability of aneurismal flow. Hemodynamics were modeled in "patient-specific" geometries, using computational fluid dynamics (CFD) simulations. Modified versions of known $\lambda 2$ and Q-criterion methods identified vortex regions by analyzing strain-rate and vorticity tensors of flow data. Identified regions were then mapped to a 3D surface structure using the classical marching cube algorithm. Temporal stability was measured by the degree of vortex overlap (DVO) of vortex structures at each step of a cardiac cycle against a cycle-averaged vortex, and by the change in number of cores over the cycle. The modified Q method was ultimately chosen over $\lambda 2$, as the $\lambda 2$ method identified weaker swirling flow deemed outside of vortex core. No statistical differences exist in DVO or number of vortex cores between 5 terminal IAs and 5 sidewall IAs. Also, no strong correlation exists between vortex core characteristics and

geometric or hemodynamic characteristics of IAs. Statistical independence suggests this proposed method may provide novel IA information unavailable using current IA analysis methods. However, threshold values used to determine the vortex core regions and resolution of velocity data influenced analysis outcomes and must be addressed in future studies. In conclusions, preliminary results show that the proposed methodology may help give novel insight toward aneurismal flow characteristic and help in future risk assessment given more developments.

Novel Materials and Transport Phenomena

Moldable Nanocomposite Hydrogel as a Fit-To-Shape Tissue Sealant Based on Mussel-Inspired Chemistry

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Mussel-inspired hydrogel had demonstrated promising biomedical application as bioadhesive and tissue sealant, yet engineering the hydrogel to desirable geometry thus fitting to various clinical situation remains a challenge. We developed a facile approach to construct a moldable nanocomposite hydrogel from mussel-inspired chemistry. The hydrogel was formed by combining dopamine-modified poly(ethylene glycol) (PEG-D) and a synthetic nanosilicate, Laponite (Na0.7+(Mg5.5Li0.3Si8)O20(OH)4)0.7–) without additional oxidative catalyst. Containing the dopamine-Laponite physical bonds and gradually increased dopamine-dopamine covalent bonds, this hydrogel underwent unique dynamic crosslinking process. At early stage it recovered to its original stiffness immediately after failure induced by shear strain up to 1000% interactions and could be reshaped to adhere to the contour of tissue due to the catechol-Laponite interactions and loosely chemically crosslinked network structure, respectively. The hydrogel gradually transformed to a densely chemically crosslinked network meanwhile fixed its shape as tissue sealant.

Self-Driving Cars: Future and Beyond

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In this age of smart phones and smart gadgets, our desire to cover miles comfortably, have been burgeoning since ever. We want our journeys to be comfortable and safe at the same time. Our main focus is shifting more and more on technologies and devices which are getting a part of our life with each passing day. Travelling through cars has not remained a passion ride, but has become a necessity, which needs to revamp in order to retain human work efficiency. My research focuses on one such aspect of transportation and automobile industry, which is poised to become a disruption in this big industry, Self-Driving Cars. Imagine a day, when you need have to get into all the dirtying hands of driving to the work or back home, when our life will be more focus on the destination rather than journey towards it. Yes, it will be same time when our roads will be safer and there won't be any causalities because of road accidents. This would the time when technology will drive us to our destination with comforts and safely and we will be left to utilize our time in focusing on other great things. Travelling will get interesting once again and this time it will be interactive to. This time it will be your very own car which will be communicating with you and will drive you to your destination. This is the future, a near reality to arrive. Self-Driving Cars, future and beyond, with unlimited possibilities and infinite applications. The next big thing is this!!!

Facile Synthesis of Polyvinylpyrrolidone (PVP)-Capped Platinum (Pt) Nanocubes with Superior Peroxidase-Like Activity

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Peroxidase mimics made of inorganic nanomaterials have been actively developed over the past decade in order to break through the confinements of the natural peroxidase. In this study, we successfully generate polyvinylpyrrolidone (PVP)-capped Pt nanocubes of sub-10 nm in size, which shows superior peroxidase-like activity. As a type of highly efficient peroxidase mimic, these PVP-capped Pt cubes are 200-fold more active than the natural counterparts and exhibit a record-high specific catalytic efficiency. In addition to that, the new mimic shows several other advantages, including excellent stabilities, well-controlled uniformity in both size and shape, controllable sizes, and facile and scalable production.

The Synthesis and Mechanism Explorations of Extreme PH, Force-Sensitive Molecules

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Environment-sensitive materials is a subject attracting many researcheres. Since this kind of materials enable materials variety proporties with the changing of environment specifically and reversibly, they are applied to wide areas like information and energy-storage. Reported environment-sensitive materials including pH sensitive, light-sensitive, temperature-sensitive and mechanochromic sensitive materials. In this paper we discuss two kinds of them, which are pH sensitive and mechanochromic sensitive materials. Although pH sensitive materials are well developed, the materials which can be sensitive to the extreme pH range, especially one fluorophores with two extreme pH switches, are relatively rarely been reported. Mechanochromic materials are rapidly developed these years. Because this is a new subject which have not been explored much, there are still problems to be solved.

Mechanical Performance Prediction for Polymer-Polymer Composites - A Comparative Study Between Various Architectures

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Design of engineering materials for impact resistant applications has been of interest to researchers over the past decades. When such materials are used as body armor and sports applications, it is necessary to make them stiff, lightweight and energy dissipative at the same time. This factor makes polymer based composites an effective solution for such applications. To achieve such competing functionalities, architectures have been introduced at multiple length scales. Such architectured materials give rise to improved properties, arising from their constituents' behavior, architecture of individual building blocks and interplay between them. Polymer filled hexagonal honeycomb structures have been extensively used in impact resistant applications. Though filled hexagonal honeycombs demonstrate excellent behavior under in-plane compression loading, their tensile properties are poor. However, a material has to be strong in tension as well as compression since it undergoes both tension and compression cycles under impact loading. The objective of this study is to determine the best designs with competing functionalities for polymer filled hexagonal honeycombs. The hexagonal architectures have been designed by considering the cellular walls made of a stiff polymer (e.g. PMMA) while the filler material has been chosen as a soft, viscous polymer (e.g. PU). Mechanical properties under tensile loading have been characterized for the design modifications in a finite element

based study where no-slip condition has been assumed between the stiff-soft polymer interfaces. In order to determine toughness as well as failure in the interfaces, contact and cohesive zones have been defined in the stiff-soft polymer interfaces. The material-property charts have been developed for the design modifications to draw a comparison between their competing properties. Subsequently, impact stress wave propagation has been investigated for the material architectures which possess better combination of conflicting properties such as stiffness and toughness.

Physical and Mathematical Sciences

Design of a Maneuverable and Adaptable Underwater Glider with Significant Payload Capacity

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In this work we present the design updates to the original ROUGHIE to improve its payload capacity, depth rating, and endurance while maintaining the same maneuverability and adaptability characteristics. The new vehicle, called ROUGHIE2, is an improvement based on lessons learned from the original ROUGHIE. It achieves a 100 meter depth rating, 600 hour endurance, and 10kg payload capacity with a total vehicle cost of approximately $10,000USD. The ROUGHIE2 redesign effort has been completed primarily to improve the mission space of the original ROUGHIE to include missions that the current ROUGHIE is unable to support. Potential missions for the ROUGHIE2 include longer duration, deeper deployments with the same maneuverability characteristics of the original ROUGHIE such as long-term water quality monitoring in the Great Lakes or near shore survey and operation for disaster relief. Additionally, the 10kg payload capacity opens up entirely new missions such as serving as a charge carrying agent in a multi-vehicle network of AUVs. The low cost, easy to modify nature of the ROUGHIE2 will streamline development of experimental glider control architectures. Motion control and coordinated navigation algorithms developed on the vehicle will be directly transferable to other internally actuated underwater gliders making the ROUGHIE2 an attractive low cost alternative to development on other gliders. The ROUGHIE2 will enable increased experimental usage of underwater gliders going forward as it is a capable and adaptable platform that is significantly easier to develop on than the commercial gliders. Novel control architectures and mechanisms can be developed on the ROUGHIE2 and later implemented onto the commercial gliders for long term deployments. Additionally, the ROUGHIE2 can also be used for missions that the legacy gliders are currently not capable of, such as navigation in enclosed environments, tight maneuvers, and significant payload missions.

Extending Maneuverability of Internally Actuated Underwater Gliders

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In the past decade Underwater Glider (UG) development reached its technical maturity. By 2004 the legacy gliders, Slocum electric, Spray, and Seaglider were successfully deployed for ocean data sampling missions. Since then several calls have been made to extend the scope of the application of these vehicles and lower the cost of manufacturing so that the fleet development is within reach. At Nonlinear and Autonomous System Laboratory (NASLab), we developed the Research Oriented Underwater Glider for Hands-on Investigative Engineering (ROUGHIE) to offer a scalable, highly maneuverable, and low-cost underwater glider. Our design methodology is to offer an open platform that is easy to modify in both software and hardware based on the intended application. With the novel

design of the internal rotary actuation in the ROUGHIE glider we aim to extend the maneuverability of this class of underwater vehicles and open new avenues for both Autonomous Underwater Vehicles and UGs mission coordination and planning specially a lower speed and shallower water with lower power consumption. The ROUGHIE has been deployed on over 200 hours of basic systems characterization tests out of which 80 hours were dedicated to roll characterization and turning motion control. Based on the initial results in the controlled environment of the swimming pool, the ROUGHIE is capable of turn radii down to approximately 3 meters, one order of magnitude less than its commercial counterparts. In this work we study the banking turn flight of underwater vehicles in more depth and develop metrics for maneuverability of this class of vehicles or alike in this sense. The parameters that defines the borders of this category for underwater vehicles will be determined and further explored. To the best of author's knowledge, there is no unique classification for underwater vehicles maneuver identification and standardization.

Molecular Characterization of Ambient and Laboratory Biomass Burning Influenced Aqueous Phase Secondary Organic Aerosol Utilizing Ultrahigh Resolution Mass Spectrometry

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Organic carbon present in biomass burning aerosol contribute to light absorption, through the presence of chromophores and intermolecular interactions, making it relevant to the global climate. In general, aerosol contribute the largest amount of uncertainty in net radiative forcing estimates because of the variety of sources and oxidative chemical aging pathways, and limited molecular characterization of the resulting complex mixture. We hypothesize that the aqueous phase processing of biomass burning emitted methoxyphenols by cloud and fog droplets, contributes to the observed light absorbing properties in natural samples, as indicated by the absorbance properties of our laboratory samples. We have utilized ultrahigh resolution mass spectrometry techniques, to study aqueous phase oxidation of biomass burning volatile emissions, in ambient and laboratory samples. Ambient samples of atmospheric aerosol and fog water from the Italian Po Valley are largely influenced by high concentrations of biomass burning emissions, as well as aqueous phase processing by fog. Four samples were selected for ultrahigh resolution mass spectrometry analysis from a larger field campaign, due to their predicted influence of either fresh emissions or secondary processes. Approximately 4500 distinct molecular formulas were identified between the samples, with an atypical large contribution of formulas containing nitrogen and sulfur. On average the samples influenced by fresh emissions had higher average double bond equivalents and average carbon number, while the samples influenced by secondary processes had higher average O/C and average H/C ratios. Several molecular formulas detected in the Po Valley samples were identical to those from ambient fog and cloud water samples previously studied, however a large fraction were not previously observed, highlighting the importance of additional studies with respect to atmospheric aerosol.

Power and Energy

Minimum Time Control of Paralleled Boost Converters

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Demand for electrification is booming in both, traditional and upcoming generations of technological advancements. One of the constituent blocks of these electrified systems is Power conversion. Power conversion systems are often constructed by paralleling multiple power converter blocks for high performance and reliability of overall system. An advanced control technique is developed with an aim to optimize system states of heterogeneous power converters within minimum time while maintaining feasible stress level on individual power converter blocks. Practical implementation of real-time controller and performance improvement strategies are addressed. Experimental results validating high performance control method, and sensitivity analysis of system parameters as measure of system robustness are presented.

Real Time Application of Battery State of Charge and State of Health Estimation

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A high voltage battery is an essential part of hybrid electric vehicles (HEVs). It is imperative to precisely estimate the state of charge (SOC) and state of health (SOH) of battery in real time to maintain reliable vehicle operating conditions. This paper presents a method of estimating SOC and SOH through the incorporation of current integration, voltage translation, and Ah-throughput. SOC estimation utilizing current integration is inadequate due to the accumulation of errors over the period of usage. Thus voltage translation of SOC is applied to rectify current integration method which improves the accuracy of estimation. Voltage translation data is obtained by subjecting the battery to hybrid pulse power characterization (HPPC) test. The Battery State of Health was determined by semi-empirical model combined with accumulated Ah-throughput method. Battery state of charge was employed as an input to estimate damages accumulated to battery aging through a real-time model. This method allows the user to monitor battery operating conditions instantaneously. The proposed method is implemented and verified by series of comprehensive hardware-in-loop (HIL) testing with high voltage HEV battery pack having a capacity of the 29Ah lithium-cobalt-oxide cell through multiple drive cycles. This technology was designed by Energy Storage Systems and Sustainability Lab at Michigan Technological University to be used in the hybrid electric vehicle based on a 1950 Chevy Truck developed at Michigan Technological University, Hybrid Electric Vehicle Enterprise.

Experimental Investigation of Water Injection Techniques in Gasoline Direct Injection Engines

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This paper describes the water injection studies conducted on a naturally aspirated single cylinder Gasoline Direct Injection (GDI) engine to optimize the combustion phasing and reduce the NOx emissions at high load conditions. Water injection systems are used to reduce NOx emissions, to improve the combustion performance at high load conditions by optimizing the combustion phasing and to improve the knock resistance by reducing the in cylinder temperatures. Experiments were conducted by injecting water into the intake manifold and the performance, combustion characteristics were determined by measuring combustion phasing, burn durations, specific fuel consumption, fuel conversion efficiency over a range of operating conditions. First set of tests included varying the Start Of Injection (SOI) for water to determine an optimized SOI wherein maximum advancement of combustion phasing was obtained. The results of the study revealed that optimum combustion phasing was achieved at 330° bTDC with water injection. At the optimized SOI, the intake temperature of air was varied from 30°C to 90°C to determine the effect of water injection on the combustion phasing and the NOx emissions. Heated intake air increases the knocking tendency of an engine due to increased charge temperature and hence to control knock below certain limits, combustion phasing needs to be retarded. Water injection helps in reduction of charge temperature which enables advancement of combustion phasing. Experimental results show that, with water injection at intake temperature of air at 90°C, the combustion phasing was advanced by 6° CA, fuel conversion efficiency increased by 1.6% compared to the baseline (without water injection) the NOx emissions were reduced by 31% due to the effectiveness of charge cooling, since at higher temperatures more of the latent heat of vaporization from water is utilized to cool the charge.

Implementation of Consensus Based Distributed Control in Power Systems Using PSCAD

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With an increase of renewable energy generators like PV and wind generators, being incorporated in existing power systems, a steady shift can be seen in the control methods of power systems from a centralized power grid to smarter and smaller micro grids with more autonomous power sharing. Even though the decentralized control of power systems is more reliable and cost effective but due to the inherent heterogeneous nature of micro grids, accurate power sharing between generators is a common issue which also results in the difficulty of voltage stabilization of the grid. The proposed consensus based algorithm is a solution proposed to overcome this problem and only requires each generator to be aware of and exchange information with directly connected neighboring generators, maintaining the power balance and voltage stability of the entire grid. The proposed method is simulated in PSCAD and its effectiveness is demonstrated using several cases.

Oral Presentation Abstracts

Advances in Biology, Biochemistry, and Biomechanics

Investigation of MiR396-GRFs Module on Tomato Plant Development and Productivity

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MiR396 is highly conserved among plant species and targets growth-regulating factors (GRFs) which are plant-specific transcription factors. According to PlantTFDB (plant transcription factor database), there are 13 GRFs in tomato, and 9 of them are mediated by miR396 from computational prediction. Blocking miR396 produces larger organs all over the plant. We applied short tandem target mimic (STTM) to down-regulate miR396 and resulted in larger plant stature, including longer hypocotyl, bigger leaves, flowers and fruits. These observations are highly correlated with crop productivity. Additionally, high-throughput RNA-sequencing was performed to detect transcriptome changes with the down-regulation of miR396. Five of the predicted GRFs were concomitantly increased in their expression, which contributed to the higher accumulation of two cell cycle associated genes, CyclinD3;3 and Cyclin B2. Another typical phenotype of miR396 down-regulation is shoot apical dominance which might be resulted from dis-regulation of Auxin-signaling pathways. Shoot apical dominance was accompanied with less axillary buds outgrowth and led to lower fruit number of each plant. With the information from RNA-seq results, fungi-resistance essay will also be performed in the near future. Our studies agree with the conserved functions of miR396 among plant species, and our findings provide important references on improving this crop productivity.

Characterization of Genic Microsatellite Markers (EST-SSRs) in the Endangered Tree *Quercus georgiana*.

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Quercus georgiana is an endangered endemic oak species that exists only in a few scattered populations in the southeastern US. The aim of the project is to characterize genic microsatellite markers (EST-SSRs) in this endangered tree species in nine populations from Georgia. A total of 27 EST-SSRs have been tested for locus-specific amplification in eight *Q. georgiana* samples from four different populations, out of which 12 have been selected based on the amplification of a single polymorphic gene locus for the analysis of all 215 samples. Samples were amplified in a GeneAmp PCR system 2700 and PCR amplicons were separated on an ABI 3730 Genetic Analyzer with the internal size standard GS-LIZ-500 and scored with GeneMarker V.2. 6.7. Genetic variation parameters expected heterozygosity (He), observed heterozygosity (Ho) and number of alleles per locus (Na) were calculated in GENAlEx6. Population structure was analyzed in STRUCTURE v. 2.3.4 using multi-locus genotype data. Observed heterozygosity (Ho) and expected heterozygosity (He) in populations ranged from 0.471 to 0.574 and from 0.447 to 0.567. There are significant differences in mean He between populations using ANOVA. The analysis of population structure identified two distinct genetic clusters, but no association between ancestry in one of the clusters and geographic location in one of the three sampled

forest fragments. Consequently, geographic proximity is not a good indicator for genetic similarity. Genetic relatedness among populations and the level of genetic variation within populations have to be considered if sampling and conservation strategies are developed for this rare and endangered species.

Characterization of a Novel Cytotoxic Hemolysin

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Lysins are cytotoxic biomolecules that can exist in the form of proteins, peptides, or glycosides. Many lysins, namely hemolysins, are known for their ability to fragment nucleated cells and erythrocytes by binding to specific membrane components. Some hemolysins can be glycan specific but their presence in nature is rare. These hemolysins often exist in bacteria, plants, invertebrate, and mammals. Recently, we found a hemolysin in the tissue of flowering plants. This hemolysin, named Hemolysin X or HelyX, was purified using ammonium sulfate precipitation, size-exclusion chromatography and high performance liquid chromatography. Microplate assays revealed that HelyX is able to lyse erythrocytes at fairly low concentrations. Carbohydrate recognition studies demonstrated that the binding partners of HelyX are two serum glycoproteins (thyroglobulin and asialofetuin) and cholesterol. Structural analysis studies of HelyX, conducted by MALDI-MS and ESI-MS, revealed the molecular weight of HelyX is in the range of 2 kDa to 10 kDa. Microscopy and flow cytometry tests of HelyX in the presence of fungal and cancer cells, showed apoptotic activity of the cancer cells and a reduction in the growth of the yeast cells.

Advances in Modern Medicine

Conductive Coaxial Nanofiber Scaffolds for Neural Tissue Engineering

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The use of electrospun polymers as scaffolds in many areas of tissue engineering, including skin, bone, cardiovascular and neural tissues has recently gained much research attention. Electrospun fibers for neural tissue applications has had some success in vitro. It has been demonstrated that directed axonal outgrowth of dorsal root ganglia (DRG) can be achieved when cultured on highly aligned electrospun nanofibers made from poly-L-lactic acid (PLLA); however, less success was achieved during in vivo studies. One method that was explored to improve in vivio culture studies was coaxial electrospinning. Multiple coaxial spinning nozzles were designed and tested with several core/sheath combinations. The objective of this study was to create fibrous scaffolds with a conductive, polymeric core and insulating PLLA sheath using these coaxial electorspinning nozzles. The idea is to use the conductive fibrous scaffolds in cell culture studies to supply an electric micro-current during in vitro cell studies, which could lead to improved axonal outgrowth in vitro. It is theorized that axonal reconnections may be influenced using electrical stimulation. Due to its stable conductive properties, low toxicity and biocompatibility we have focused on electrospinning poly(3,4-ethylene dioxythiophene) (PEDOT) with polystyrene sulfonate (PSS) as the counter ion to improve solubility and conductivity. The creation of aligned, coaxial PLLA/PEDOT-PSS nanofibers has been explored, and the resulting fibers characterized via fluorescence microscopy and SEM. The fibers have been found to be consistently coaxial. Furthermore, examination of the SEM imaging indicates that the core of the fibers containing PEDOT is conductive. Aligned scaffolds made of these fibers will be used in future in vitro cell studies.

Assessing the Immunogenicity of Potential Zika Virus B Cell Epitopes on Phage Virus-like Particles

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Zika virus (ZIKV) is an arthropod-borne flavivirus that is transmitted predominantly through mosquitoes. Within the last decade, ZIKV infection has spread around the world especially into Latina America. ZIKV infection is associated with guillain-barré syndrome, microcephaly, and miscarriage. Currently, there are no drugs or vaccines to protect against ZIKV infections. Moreover, there is no information on epitopes that could be targeted for peptide vaccine design. Previous bioinformatics studies had identified B-cell epitopes on ZIKV envelope proteins. However, the immunogenicity of these epitopes has never been assessed. In order to assess the immunogenicity of these epitopes and their ability to neutralize ZIKV infection, we displayed the epitopes on highly immunogenic virus-like particles (VLPs) platforms derived from MS2 and Qβ phages using both genetic insertion as well as chemical conjugation approaches. We assessed, in mice, the immunogenicity of the ZIKV peptides displayed on VLPs as well as the immunogenicity of a ZIKV envelope protein. Immunizations with epitopes representing amino acid 241-259, 294-315, 346-361, 421-437 and 377-388 displayed on phage VLPs or immunization with ZIKV envelope protein elicited anti-ZIKV antibody responses. Our preliminary data show that these anti-ZIKV antibodies can neutralize, at low titers, ZIKV strain MR-766. This suggests that some of these epitopes are B cell epitopes.

MS2 Bacteriophage VLPs Displaying Multiple HPV L2 Epitopes Show Protective Antibody Responses Against Three HPV Types

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Human papillomaviruses (HPVs) are the causative agents of human neoplasias such as warts and cancers. Although three prophylactic vaccines have been approved to protect against HPV infections, these vaccines protect mostly against the HPV types included in the vaccines. The new Gardasil-9 protects against HPV types that cause 90% and 86% of HPV-associated cervical and penile cancers, respectively; however, the vaccine has not yet been recommended to recipients of first-generation HPV vaccines and as such, recipients of first generation HPV vaccines are protected only against HPV types that cause 70% and 53-79% of cervical and penile cancers, respectively. With this in consideration, there is still a need to develop a broadly protective HPV vaccine. Our group had previously shown that immunization with MS2 bacteriophage VLPs displaying a single conserved L2 epitope offers protection from vaginal infection with a broad range of diverse HPV types associated with cancer. However, there was suboptimal protection against some HPV types. To enhance protection against these HPV types, we have developed bacteriophage virus-like particles (VLPs) displaying three epitopes from HPVs. Mice immunized with these VLPs elicit immune response against these HPV epitopes and show broad protective antibody response against three HPV pseudoviruses. Taken together, these results suggest that immunization with multiple L2 epitope MS2 VLPs is an excellent approach to broaden antibody responses against multiple HPV types.

Engineering Oriented Microvessels on Aligned Extracellular Matrix Scaffold

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Creating aligned microvessels on tissue engineered scaffolds can provide natural inlets/outlets for perfusion and meet the functional requirement of certain tissue types

such as cardiac tissues and nerves. Pre-vascularized naturally derived extracellular matrix (ECM) scaffold holds great potential in creating aligned three-dimensional (3D) pre-vascularized tissues when layered or combined with other biomaterials. The objective of this study was to demonstrate that aligned pre-vascularized ECM could be created by seeding human mesenchymal stem cells (hMSCs) on aligned ECM nanofibers to facilitate the oriented vasculature formation of endothelial cells (ECs). The mechanism behind vessel alignment was investigated by examining the microvessel morphology, angiogenic growth factors and cell adhesion protein secretion, as well as the basement membrane remodeling related matrix metalloproteinase (MMP) expression. Results have shown that aligned ECM nanofibers could guide the orientation of microvascular networks and promote microvessel formation with the aid of hMSCs. hMSCs and ECs co-culture released more angiogenic growth factors on aligned scaffolds during co-culture. More focal adhesion genes were expressed in the aligned scaffolds during the microvessel formation. The MMP-2 was activated earlier in aligned scaffolds than randomly organized scaffolds during the microvessel formation, indicating that the remodeling of basement membrane of ECs started earlier in aligned scaffolds. The aligned nanofibrous ECM scaffold with oriented microvessels holds great potential in biofabrication of 3D aligned functional tissues including cardiac tissues, skeletal muscles, and neural tissues.

Acidification with Acetic Acid Activates NMDAR and Increases Excitability of Central Nucleus of Amygdala Neurons with Axon Projecting to Rostral Ventrolateral Medulla

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We have previously demonstrated that bath application of acetate caused a dose dependent increase in the in vitro excitability of CeA neurons with axon projecting to rostral ventrolateral medulla (CeA-RVLM). We hypothesized that intraneuronal acidification due to acetate may be a contributing factor. In cultured neurons incubated with a pH sensitive probe, increases in bath application of acetate (2, 7.5 and 37.5 mM) significantly ($p < 0.05$) increased the corrected fluorescence intensity of neurons compared to control, indicative of acidification. Blockade of NMDAR with memantine abolished the acetate induced increase in cytosolic calcium, but had no effect on acidification. Next, the role of intraneuronal acidification with acetic acid was investigated under brain slice preparation. Specifically, we compared the action potential firing rate, depolarizing input resistance (R-input), and voltage threshold (Vt) for firing action potentials between control intracellular recording solution (pH = 7.35) and 7.5 mM acetic acid loaded intracellular recording solution (pH = 5.20). In current-clamp recordings, graded current injections evoked graded increases in discharge frequency among neurons from both groups. Maximum discharge evoked by +250 pA current injection in the acetic acid loaded (pH = 5.20) group was 31 ± 4 Hz (n=8), which was significantly greater ($p < 0.05$) than that of control group (pH = 7.35, 19 ± 1 Hz, n=7). NMDAR blocker had no effect on maximum firing rate +250 pA with intracellular loaded acetic acid. However, acetic acid and NMDAR block did significantly ($p < 0.05$) attenuate the gain of the current stimulus response compared to acetic acid alone. Intraneuronal acidification with acetic acid significantly ($p < 0.05$) increased R-input of CeA-RVLM neurons, and caused a hyperpolarizing shift in Vt (-49.28 ± 1.37 mV) compared to control neurons (-43.83 ± 1.76 mV). This data suggests that pH has profound effects on NMDAR and neuronal excitability.

Arts and Humanities

Using Critical Discourse Analysis to Understand Power, Hegemony, and Blame in the Stanford Rape Case

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The 2015 Stanford sexual assault case of Emily Doe v. Brock Turner provides a provocative setting for a Critical Discourse Analysis (Fairclough, 2013) of courtroom discourse. As with Ehrlich (2001), I examine the linguistic means by which the institutionalized practices of the legal system engender unequal power relations and re-frame narratives to construct gendered ideologies that shape our responses to violence against women. For example, in her statement the complainant Doe describes the event 22 times as an "assault" and 11 times as a "sexual assault," whereas the defendant, Turner, never once refers to his actions as a sexual assault or an assault, instead, refers to it as an event. A careful comparison of each side's use of transitivity, suppression, lexicalization, and signification demonstrates further how these narratives are used to intentionally influence the social construction and social acceptance of these events, actors, and identities. While the courtroom is framed as a space to allow both sides an equivalent voice, the close analysis of both speech and silence reveal how specific linguistic features operate to shift power, personal agency, and accountability; thus, unsurprisingly, although Turner was found guilty of three felonies, he served just three months in a county jail.

Food from the African Soul: On Rhetoric and Ideology in Contemporary Ghanaian Cookbooks

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Technical documents are often interpreted as functional texts whose social, cultural and political dimensions could be ignored. Miller (1979 [2004]), however, argues that such a view presupposes a "window pane theory of language" influenced by a positivist epistemology that considers rhetoric as irrelevant to technical and scientific communication" and further suggests a communalist and "fragrantly rhetorical" approach to technical writing-- one that considers technical writing as a kind of enculturation (52). Following Miller's comment, this paper examines the rhetoric of Ghanaian cookbooks by focusing particularly on the strategies employed by the rhetors of these texts in envisioning a purpose, constructing an audience, constructing themselves as rhetors and projecting individual as well as communal identities. The discussion is theoretically underpinned by Miller's (1986 & 2015) notion of genre as social action and employs a mixed methods approach that combines concepts from rhetoric, semiotics and postcolonial studies. The paper will ultimately argue that the rhetoric of contemporary Ghanaian cookbooks are inherently contradictory in that they construct Ghana as an imagined community while targeting the West as its audience even as it essentializes, commodifies and exoticizes Ghanaian (African) cultures. Through this analysis of the intersection between rhetoric and ideology in Ghanaian cookbooks, this paper opens up unique cultural perspectives that may be significant for discussions in intercultural technical communication.

Environmental Studies

Analytical Modeling of Krauklis Waves in a Thin Hydraulic Fracture

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In an open fluid-filled channel or fracture, seismic waves can be trapped along the fractured medium. These waves are sometimes called crack waves or Krauklis waves and result from the acoustic vibrations of the fluid with the resonating elastic layers. They are characterized by high dispersion at low frequencies and possessed dominantly high amplitudes etc. Most of the previous analytical models developed to study the propagation of these waves, have considered a fracture model with identical elastic properties. This allows symmetry to be introduced and the solutions of the wave equation in such medium are sought for half the fracture model (i.e. from the middle of the fluid layer to the top of one of the elastic-half spaces) and consequently result into the dispersion equation. In this study, I consider the analysis of these waves in fracture models with different material properties by solving the equation of motions in the fluid and the solids simultaneously and compare the results with those with identical properties (For both elastic half-spaces and thin plates). The results confirm the existence of a very slow dispersive wave in the fluid layer. Three fracture models are investigated: hard formation (Aluminum-fluid-Aluminum); soft formation (Lucite-fluid-Lucite) and 'composite' formation (lucite-fluid-aluminum). The results, however, show that the elastic properties slightly affect the phase velocity of the wave. The thickness of the elastic layers also influences the propagation of the wave by decreasing its phase velocity as the thickness increases. These results have special implications for laboratory studies where the material properties of physical models become crucial parameter to decipher couple with the thickness of the elastic layers for optimum excitation of the waves within the fluid-filled fracture.

Afforested Plantations Alter Ecosystem Services in Pampas Grasslands in Argentina

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Ecosystem services provide essential goods and services to human communities, but many of these services can be impacted by land-use change. In Entre Ríos province in northeastern Argentina, large-scale eucalyptus plantations are replacing ranchlands and annual crops as the dominant use. These afforested eucalyptus plantations represent a new land use in a region that historically was once part of the Pampas grassland. Favorable government policies and market conditions will likely result in the continued expansion of large-scale monocultures of even-aged eucalyptus stands with unknown consequences for multiple ecosystem services. To clarify and quantify the potential trade-offs between expanding plantations and ecosystem services, we modeled changes in pollination services, carbon sequestration, and biodiversity using InVEST ecosystem service modeling software using both primary and secondary data sources. We considered two future scenarios, one representing "business as usual" based upon land-use trends from the last 10 years and a second scenario representing an acceleration of eucalyptus replacing pastures, which is expected based on expanded tax incentives for forestry, and contrasted these with a 2014 baseline land use map. We also incorporated the community values of the region, based on

interviews and social surveys, to capture social acceptability and local perspective of plantations. Preliminary results suggest that the expansion of eucalyptus will cause a decline in pollination service provided by wild bees and a reduction in bird species richness, along with variable changes in soil carbon values. The degree of eucalyptus expansion drove much of the changes in ecosystem services. These results suggest that the expansion of eucalyptus plantations will likely result in the reduction of our modeled ecosystem services. Final results will further incorporate effects on water usage of eucalyptus plantations, both as stand and landscape perspective

Physical Factors of Accelerated Warming of Lake Superior

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The climate change induced lake warming in high latitude regions has recently received extensive research and public attention. Due to limited data coverage, particularly during the harsh wintertime, how to assess and quantify the lake warming remains an open question. Using a 3-D circulation model driven by Climate Forecast System Reanalysis (CFSR) forcing, the physical factors of accelerated warming of Lake Superior are investigated with different process-oriented numerical experiments. The variation of the water mixing strength, the ice albedo feedback, and the ice insulation effect, play critical roles in controlling heat content and heat distribution in the lake by altering the structure of thermocline and the air-water heat flux exchange.

Water Quality Improvement in Drinking Water Storage Tanks Through Stagnation Reduction

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Poor mixing in water storage tanks can cause stagnation that could pose negative public health effects. To eliminate stagnant zones in a cylindrical water storage tank, this study investigated the feasibility of a novel internal piping configuration consisting of a sprinkler-type inlet piping that distributed the incoming flow evenly across the water surface and a corresponding upside-down sprinkler draining configuration at the tank bottom. Experiments were performed using acoustic Doppler velocimeter (ADV) and electrical conductivity (EC) measurements. Various stagnation metrics, like the time for the water to be well-mixed, and water particle velocity and direction, were employed for each configuration. Inlet/outlet convergence time is defined as a simple indicator, in which the lower the value, the higher the risk of short-circuiting. In the next step, experiments were performed with a temperature difference between the tank and the inflow due to density-driven flows. Results indicated that the novel piping resulted in parallel downward streamlines that eliminated most of the stagnation zones in the tank.

The Impact of Coastal Hydrodynamics on Local Ecosystem in the Lake Ontario Nearshore

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A near-continuous band of urban landscape occupies the shoreline of western Lake Ontario, hosting a population that turns to the lake as a source of drinking water and a location for waste disposal. Renewed interest in the nearshore has focused attention on cases where receptors are impacted by previously unattended (the phosphorus-Cladophora dynamic) and emerging (pharmaceuticals and personal care products) pollutants of concern. Here, a spatially intense calibration and confirmation of the next-generation

hydrodynamic model FVCOM supports wastefield characterization at a site where municipal waste discharges are juxtaposed with a water intake and Cladophora habitat. Simulations confirm that effluents discharged to the nearshore are not rapidly transported to the offshore, but rather remain for extended periods in waters <30 m, i.e. those with receptor sites sensitive to effluent constituents. Management of nearshore water quality utilizes a mixing zone concept, seeking to minimize the area over which effluent plume constituent concentrations exceed water quality standards. In the case of the phosphorus-Cladophora dynamic, the ratio of effluent soluble reactive phosphorus (SRP) concentration to that required for protection against nuisance algal growth significantly exceeds that for pollutants addressed within the contemporary regulatory structure. The result is that the SRP wastefield is potentially much larger (tens of kilometers) than that for traditional pollutants (hundreds of meters). This leads to a concomitant increase in the dilution ratio required to minimize the mixing zone (e.g. 100-200:1 versus 20:1). The attendant need may be met through advanced wastewater treatment and/or further extension of the offshore point of discharge.

Measurement Techniques and Analysis Methods

Vortex Analysis of Intra-Aneurismal Flow in Cerebral Aneurysms

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Intracranial aneurysms (IAs) are thinning spots (ballooning) of cerebral arteries. Affecting ~3% of the population, IAs cause neurological damage or death in the event of IA rupture. Currently, morphological parameters of IAs, and hemodynamic stressors along the IA wall are the basis for clinical prediction of IA rupture. These metrics help dictate clinical intervention, yet predictions vary in accuracy. This initial study aims to develop an alternative analysis method by measuring structure of IA swirling flow patterns (vortexes) across the cardiac cycle, to quantify temporal stability of aneurismal flow. Hemodynamics were modeled in "patient-specific" geometries, using computational fluid dynamics (CFD) simulations. Modified versions of known $\lambda 2$ and Q-criterion methods identified vortex regions by analyzing strain-rate and vorticity tensors of flow data. Identified regions were then mapped to a 3D surface structure using the classical marching cube algorithm. Temporal stability was measured by the degree of vortex overlap (DVO) of vortex structures at each step of a cardiac cycle against a cycle-averaged vortex, and by the change in number of cores over the cycle. The modified Q method was ultimately chosen over $\lambda 2$, as the $\lambda 2$ method identified weaker swirling flow deemed outside of vortex core. No statistical differences exist in DVO or number of vortex cores between 5 terminal IAs and 5 sidewall IAs. Also, no strong correlation exists between vortex core characteristics and geometric or hemodynamic characteristics of IAs. Statistical independence suggests this proposed method may provide novel IA information unavailable using current IA analysis methods. However, threshold values used to determine the vortex core regions and resolution of velocity data influenced analysis outcomes and must be addressed in future studies. In conclusions, preliminary results show that the proposed methodology may help give novel insight toward aneurismal flow characteristic and help in future risk assessment given more developments.

Novel Materials and Transport Phenomena

Moldable Nanocomposite Hydrogel as a Fit-To-Shape Tissue Sealant Based on Mussel-Inspired Chemistry

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Mussel-inspired hydrogel had demonstrated promising biomedical application as bioadhesive and tissue sealant, yet engineering the hydrogel to desirable geometry thus fitting to various clinical situation remains a challenge. We developed a facile approach to construct a moldable nanocomposite hydrogel from mussel-inspired chemistry. The hydrogel was formed by combining dopamine-modified poly(ethylene glycol) (PEG-D) and a synthetic nanosilicate, Laponite (Na0.7+(Mg5.5Li0.3Si8)O20(OH)4)0.7–) without additional oxidative catalyst. Containing the dopamine-Laponite physical bonds and gradually increased dopamine-dopamine covalent bonds, this hydrogel underwent unique dynamic crosslinking process. At early stage it recovered to its original stiffness immediately after failure induced by shear strain up to 1000% interactions and could be reshaped to adhere to the contour of tissue due to the catechol-Laponite interactions and loosely chemically crosslinked network structure, respectively. The hydrogel gradually transformed to a densely chemically crosslinked network meanwhile fixed its shape as tissue sealant.

Driving Selflessly into new age: Smart Cars

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In this age of smart phones and smart gadgets, our desire to cover miles comfortably, have been burgeoning since ever. We want our journeys to be comfortable and safe at the same time. Our main focus is shifting more and more on technologies and devices which are getting a part of our life with each passing day. Travelling through cars has not remained a passion ride, but has become a necessity, which needs to revamp in order to retain human work efficiency. My research focuses on one such aspect of transportation and automobile industry, which is poised to become a disruption in this big industry, Self-Driving Cars. Imagine a day, when you need have to get into all the dirtying hands of driving to the work or back home, when our life will be more focus on the destination rather than journey towards it. Yes, it will be same time when our roads will be safer and there won't be any causalities because of road accidents. This would the time when technology will drive us to our destination with comforts and safely and we will be left to utilize our time in focusing on other great things. Travelling will get interesting once again and this time it will be interactive to. This time it will be your very own car which will be communicating with you and will drive you to your destination. This is the future, a near reality to arrive. Self-Driving Cars, future and beyond, with unlimited possibilities and infinite applications. The next big thing is this!!!

The Synthesis and Mechanism Explorations of Extreme PH, Force-Sensitive Molecules

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Environment-sensitive materials is a subject attracting many researcheres. Since this kind of materials enable materials variety proporties with the changing of environment specifically and reversibly, they are applied to wide areas like information and energy-

storage. Reported environment-sensitive materials including pH sensitive, light-sensitive , temperature-sensitive and mechanochromic sensitive materials. In this paper we discuss two kinds of them, which are pH sensitive and mechanochromic sensitive materials. Although pH sensitive materials are well developed, the materials which can be sensitive to the extreme pH range, especially one fluorophores with two extreme pH switches, are relatively rarely been reported. Mechanochromic materials are rapidly developed these years. Because this is a new subject which have not been explored much, there are still problems to be solved.

A First Principles Study of Tunnel Magnetoresistance in Carbon Nanotube Junction

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When a thin semiconducting layer acts as a tunnel barrier between two ferromagnetic (FM) contacts, the resistance in the circuit depends upon the relative orientation of the electron-spins between the contacts. Typically, the resistance changes from maximum to minimum depending upon whether the spins in the magnetic contacts are in anti-parallel or parallel spin configuration. The relative difference in resistance between these two magnetic configurations is known as tunnel magnetoresistance (TMR)-a phenomenon, which plays a vital role in high density data storage device. Intrigued by the weak spin-orbit and hyperfine interaction in carbon nanotube (CNT), researchers have used CNT as a spin transport channel between FM leads to design a next generation magneto resistive device [1, 2]. A spin flip scattering length of up to 250 nm has been reported [1] in the case of multiwall carbon nanotubes contacted to ferromagnetic (Co) leads. In addition, sign reversal of magnetoresistance is also observed [2] in both single-wall and multiwall carbon nanotubes contacted to PdNi leads. Despite these pioneering experimental efforts, lack of complete control over chirality and incomplete understanding of the FM-CNT interface make it harder to reproduce these results for practical applications. Understanding the role of spin-interface [3] at the CNT-FM junction is fundamental to developing a next generation magnetoresitive device. Herein, we have used a semiconducting single-wall CNT as a channel between two ferromagnetic electrodes to investigate the spin injection efficiency and tunnel magnetoresistance behavior in a prototypical CNT junction. A first-principles spin polarized density functional theory in conjunction with a single particle many-body Green's function approach is used to probe the electric field manipulation of spin polarized current in a CNT-FM junction. Our calculations show that the sign of the tunnel magnetoresistance can be switched from positive to negative, which is consistent with the experimental observation.

Corrosion Characteristics Dictate the Long-Term Inflammatory Response and Biocompatibility of Degradable Zinc-Based Arterial Implants for Stent Applications

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There has been considerable recent interest to develop a feasible bioresorbable stent metal. Although zinc and its alloys have many potential advantages, the inflammatory response has not been carefully examined. Additionally, in-vivo studies in literature are non-existent, besides our groups most recent work . Using a modified wire implantation model, we characterize the inflammatory response elicited by zinc at high purity (4N) [99.99%], special high grade (SHG)[~99.7%], and alloyed with 1 wt % (Zn-1Al), 3% (Zn-3Al), and 5.5% (Zn-5Al) aluminum. We found that inflammatory cells were able to penetrate the thick and porous corrosion layer that quickly formed around SHG, Zn-1Al, Zn-3Al, and

Zn-5Al implants. In contrast, a delayed entrance of inflammatory cells into the corrosion layer around 4N zinc at early months due to a significantly lower corrosion rate was associated with greater fibrous encapsulation, appearance of necrotic regions, and increased macrophage labeling. Interestingly, cell viability at the interface decreased from SHG, to Zn-1Al, and then Zn-3Al, a trend associated with an increased CD68(pan macrophage) and CD11b(aggressive macrophage) labeling and capsule thickness. Potentially, the shift to intergranular corrosion due to the aluminum addition increased the activity of macrophages. Corrosion product characteristics could also influenced macrophage recruitment and phenotype.. We conclude that the ability of macrophages to penetrate and remain viable within the corrosion layer may be of fundamental importance for eliciting biocompatible inflammatory responses around corrodible metals.

Stability and Electronic Properties of Amine Functionalized Boron Nitride Nanostructures

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Boron nitride nanotubes and monolayers are hydrophobic and exhibit low chemical reactivity, which results in poor utility in sensing applications. This behavior leads to a low and degenerate affinity to biological molecules. The bio-nano interface with polar and nonpolar amino acids is governed by weak van der Waals forces, resulting in poor specificity. To utilize the boron nitride nanostructure's intrinsic properties, the structures can be functionalized with different molecules modifying their interfacial behavior, while still retaining these properties. Experiments have demonstrated the ability to deposit amine groups forming sp3 bonded groups in the two-dimensional network of sp2 bonded hexagons using an ammonia plasma treatment. The amine groups provide the nanotubes with polar appendages that increases their efficacy as biosensors. The effect of the functionalization, with amine groups, was investigated using density functional theory with the addition of an empirical correction to capture the van der Waals interactions. We provide a description of the modifications of the physical and electronic properties of the boron nitride nanomaterials and their interaction with select amino acids.

Physical and Mathematical Sciences

Design of a Maneuverable and Adaptable Underwater Glider with Significant Payload Capacity

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In this work we present the design updates to the original ROUGHIE to improve its payload capacity, depth rating, and endurance while maintaining the same maneuverability and adaptability characteristics. The new vehicle, called ROUGHIE2, is an improvement based on lessons learned from the original ROUGHIE. It achieves a 100 meter depth rating, 600 hour endurance, and 10kg payload capacity with a total vehicle cost of approximately $10,000USD. The ROUGHIE2 redesign effort has been completed primarily to improve the mission space of the original ROUGHIE to include missions that the current ROUGHIE is unable to support. Potential missions for the ROUGHIE2 include longer duration, deeper deployments with the same maneuverability characteristics of the original ROUGHIE such as long-term water quality monitoring in the Great Lakes or near shore survey and operation for disaster relief. Additionally, the 10kg payload capacity opens up entirely new missions such as serving as a charge carrying agent in a multi-vehicle network of AUVs. The low cost, easy to modify nature of the ROUGHIE2 will streamline development of

experimental glider control architectures. Motion control and coordinated navigation algorithms developed on the vehicle will be directly transferable to other internally actuated underwater gliders making the ROUGHIE2 an attractive low cost alternative to development on other gliders. The ROUGHIE2 will enable increased experimental usage of underwater gliders going forward as it is a capable and adaptable platform that is significantly easier to develop on than the commercial gliders. Novel control architectures and mechanisms can be developed on the ROUGHIE2 and later implemented onto the commercial gliders for long term deployments. Additionally, the ROUGHIE2 can also be used for missions that the legacy gliders are currently not capable of, such as navigation in enclosed environments, tight maneuvers, and significant payload missions.

Extending Maneuverability of Internally Actuated Underwater Gliders

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In the past decade Underwater Glider (UG) development reached its technical maturity. By 2004 the legacy gliders, Slocum electric, Spray, and Seaglider were successfully deployed for ocean data sampling missions. Since then several calls has been made to extend the scope of the application of these vehicles and lower the cost of manufacturing so that the fleet development is within reach. At Nonlinear and Autonomous System Laboratory (NASLab), we developed the Research Oriented Underwater Glider for Hands-on Investigative Engineering (ROUGHIE) to offer an scalable, highly maneuverable, and low-cost underwater glider. Our design methodology is to offer an open platform that is easy to modify in both software and hardware based on the intended application. With the novel design of the internal rotary actuation in the ROUGHIE glider we aim to extend the maneuverability of this class of underwater vehicles and open new avenues for both Autonomous Underwater Vehicles and UGs mission coordination and planning specially a lower speed and shallower water with lower power consumption. The ROUGHIE has been deployed on over 200 hours of basic systems characterization tests out of which 80 hours were dedicated to roll characterization and turning motion control. Based on the initial results in the controlled environment of the swimming pool, the ROUGHIE is capable of turn radii down to approximately 3 meters, one order of magnitude less than its commercial counterparts. In this work we study the banking turn flight of underwater vehicles in more depth and develop metrics for maneuverability of this class of vehicles or alike in this sense. The parameters that defines the borders of this category for underwater vehicles will be determined and further explored. To the best of author's knowledge, there is no unique classification for underwater vehicles maneuver identification and standardization.

What Time Is Sunrise? Revisiting the Refraction Component of Sunrise/set Prediction Models

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Algorithms that predict sunrise and sunset times currently have an error of one to four minutes at the tropics and mid-latitudes (0° - 55° N/S) due to limitations in the atmospheric models they incorporate. At higher latitudes, slight changes in refraction can cause significant discrepancies, even including difficulties determining when the Sun appears to rise or set. While different components of refraction are known, how they affect predictions of sunrise/set has not yet been quantified. A better understanding of the contributions from temperature profile, pressure, humidity, and aerosols could significantly improve the

standard prediction. We present a sunrise/set calculator that interchanges the refraction component by varying the refraction model. We then compare these predictions with data sets of observed rise/set times to create a better model. Sunrise/set times and meteorological data from multiple locations will be necessary for a thorough investigation of the problem. While there are a few data sets available, we will also begin collecting this data using smartphones as part of a citizen science project. The mobile application for this project will be available in the Google Play store. Data analysis will lead to more complete models that will provide more accurate rise/set times for the benefit of astronomers, navigators, and outdoorsmen everywhere.

Delay Efficient RSU Placement Algorithm for VANET Safety Applications

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Vehicular ad-hoc networks (VANETs) have been envisioned to prominently enhance the road safety and traffic efficiency through real-time vehicle-to-vehicle and vehicle-to-infrastructure communications. Roadside Units (RSUs) play an important role in vehicular environments in terms of connectivity, routing, and transmission delay. However, deploying enough RSUs to provide a universal coverage within an area is not feasible. In addition, there still lacks understanding of the performance of message dissemination in urban environments where one deploys RSUs in stand-alone fashion. In this study, we provide insight into the performance of message dissemination in such environments and propose a Safety-Based RSU Placement algorithm (S-BRP). We evaluate the S-BRP algorithm through extensive simulation studies. The results demonstrate that the proposed algorithm outperforms Mesh, the alternate deployment policy, in terms of the dissemination delay and traffic flow.

Adsorption and Diffusion Mechanisms of C1-C4 Hydrocarbon Molecules in MOF-74-Mg/Zn: A Quantum Chemical study on Selective Gas Separation Applications in Petroleum Refining Industries

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Metal Organic Frameworks (MOFs) have become ubiquitous in recent studies and have received ample attention in the literature. MOFs' peculiar nature presents several advantages including the engineering of structures characterized by void cavities which can easily be functionalized to achieve various purposes including gas molecules separation. Olefin-paraffin separation is one of the most promising applications in petroleum refineries. Currently, such separation is commonly achieved via cryogenic distillation, an energetically and monetarily expensive process. In this regard, selective sorption achieved by porous materials at temperature closer to those of the cracking process and ambient pressure is considered to be most promising. Although a few experimental and computational studies have been recently reported on the potential use of MOF-74-Mg/Zn as adsorbents with respect to light hydrocarbons, a detailed description of the physicochemical adsorption and diffusion mechanisms of these molecules in the framework is still lacking. The aim of this work is manifold. From fundamental point view, it addressees the structural and energetic interaction of C1-C4 molecules at the open metal sites in the frameworks. From applied stand point, (i) it provides an understanding in the olefin-paraffin selective sorption of MOF- 74-Mg/Zn for the separation of C1-C4 mixtures, (ii) investigates the influence of the most commonly pre-adsorbed contaminant molecules

such as H2O on diffusion process of small hydrocarbons in the MOFs. To model the molecular diffusion, climbing-image nudge elastic band (CI-NEB) simulations coupled with density functional theory (DFT) are performed. In order to handle the long range interaction driving the adsorption and diffusion of the gas molecules, the Van der Waals functional (vdW-DF) is employed together with ultra-soft pseudopotential as implemented in the Quantum Espresso package.

Stacking Analysis of Binary Systems with HAWC

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Detecting binary systems at TeV energies is an important problem because only a handful of such systems are currently known. The nature of such systems is typically thought to be composed of a compact object and a massive star. The TeV emission from these systems does not obviously correspond to emission in GeV or X-ray, where many binary systems have previously been found. This study focuses on a stacking method to detect TeV emission from LS 5039, a known TeV binary, to test its efficacy in HAWC data. Stacking is a widely employed method for increasing signal to noise ratio in optical astronomy, but has never been attempted previously with HAWC. HAWC is an ideal instrument to search for TeV binaries, because of its wide field of view and high uptime. Applying this method to the entire sky may allow HAWC to detect binary sources of very short or very long periods not sensitive to current analyses.

Investigating Large Galactic Gamma-ray Structures with the HAWC Observatory

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The observation of large gamma-ray emission structures is useful for tracing the distribution and propagation of cosmic rays throughout our Galaxy. For example, the search for gamma-ray emission from Giant Molecular Clouds may allow us to probe the flux of cosmic rays in distant galactic regions and compare it with the flux measured at Earth. Also, by observing at the gamma ray signal, the composition of the cosmic rays can be measured by studying the emission from hadronic or leptonic processes. In the case of emission from the Fermi Bubbles specifically, constraining the mechanism of gamma ray production can point to their origin. The High Altitude Water Cherenkov (HAWC) Observatory is located at 4100m above sea level in Mexico. It is designed to measure high-energy gamma rays between 300GeV to 100TeV. I will present preliminary results from the HAWC Observatory in the search of gamma-ray emission from large structures.

Computationally Efficient Density Estimation Over Non-Stationary High-Dimensional Data Streams

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We are definitely living in the age of data, where huge volumes of various types of data are being collected every day, from a wide range of sources. In many practical applications today, there is a need to process data over an open-ended stream, as they arrive, as opposed to processing the stationary data stored in a database. Traffic control, satellite monitoring and sensor networks are some of the examples. Density estimation is a fundamental part of statistical analysis and serves as the basis of many other data mining and machine learning techniques, including classification, clustering, bump hunting, etc. In general, parametric

methods for density estimation are not suitable in high-dimensional domains, due to the curse of dimensionality, where the number of parameters rapidly increases with the sample size and the dimension. Also, widely used non-parametric methods like kernel method fail for dimensions higher than 4 or 5. In this work, I present a computationally efficient framework for online density estimation for high-dimensional data. It is based on Bayesian Sequential Partitioning (BSP) method, which constructs a multidimensional histogram by making sequential binary cuts in D-dimensional sample space. The online density estimator collects and processes "blocks" of data, of certain size, as they arrive, applies BSP to each block of data, and performs a moving average over the estimated densities from the most recent blocks to estimate the probability density function. The proposed algorithm is then extended to non-stationary data streams, where the underlying probability distribution can change over time. The optimum block size and averaging window size may vary from case to case and need to be determined based on memory limitations, the arrival rate of data, and how frequently the underlying density changes. The proposed method is applied to a set of synthetic and actual datasets, to demonstrate its performance.

Power and Energy

Performance Analysis of Stall Controlled Variable Speed Wind Turbines Under Gust Loading Conditions

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Renewable Energy, especially wind energy power systems, has been growing over time and become an important source for fuel and energy storage. Energy demand, has made Wind the fastest growing renewable energy technology in electricity systems. One of the remarkable advantages of this energy in comparison to other renewable sources, is the lack of harmful emissions and so does not pose a danger to the environment. This makes wind energy production competitive with other energy resources. For example, variable-speed generation can capture more energy and also has lower loading. There is blade inertia in variable speed operation which helps in energy storage during acceleration. Wind turbines convert the available energy in air into electricity. The amount of electrical power directly depends on the method used for controlling the generator. In variable speed wind turbines, control strategy has a significant role. Stall and pitch control are two different approaches for controlling the power in variable wind speed. Working with variable speed wind turbine lets us operate near maximum efficiency in low to moderate wind speed. Variable speed wind turbines use power electronics and aerodynamic control strategies to control torque, power and also rotational speed of the blade. By using variable speed wind turbine torque will be limited and this will reduce the stresses caused by wind gusts. Variable speed wind turbines have lower loading and capture energy better than the fixed speed ones.

Real Time Application of Battery State of Charge and State of Health Estimation

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A high voltage battery is an essential part of hybrid electric vehicles (HEVs). It is imperative to precisely estimate the state of charge (SOC) and state of health (SOH) of battery in real time to maintain reliable vehicle operating conditions. This paper presents a method of estimating SOC and SOH through the incorporation of current integration, voltage translation, and Ah-throughput. SOC estimation utilizing current integration is inadequate due to the accumulation of errors over the period of usage. Thus voltage translation of SOC is applied to rectify current integration method which improves the accuracy of estimation. Voltage translation data is obtained by subjecting the battery to

hybrid pulse power characterization (HPPC) test. The Battery State of Health was determined by semi-empirical model combined with accumulated Ah-throughput method. Battery state of charge was employed as an input to estimate damages accumulated to battery aging through a real-time model. This method allows the user to monitor battery operating conditions instantaneously. The proposed method is implemented and verified by series of comprehensive hardware-in-loop (HIL) testing with high voltage HEV battery pack having a capacity of the 29Ah lithium-cobalt-oxide cell through multiple drive cycles. This technology was designed by Energy Storage Systems and Sustainability Lab at Michigan Technological University to be used in the hybrid electric vehicle based on a 1950 Chevy Truck developed at Michigan Technological University, Hybrid Electric Vehicle Enterprise.

Experimental Investigation of Water Injection Techniques in Gasoline Direct Injection Engines

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This paper describes the water injection studies conducted on a naturally aspirated single cylinder Gasoline Direct Injection (GDI) engine to optimize the combustion phasing and reduce the NOx emissions at high load conditions. Water injection systems are used to reduce NOx emissions, to improve the combustion performance at high load conditions by optimizing the combustion phasing and to improve the knock resistance by reducing the in cylinder temperatures. Experiments were conducted by injecting water into the intake manifold and the performance, combustion characteristics were determined by measuring combustion phasing, burn durations, specific fuel consumption, fuel conversion efficiency over a range of operating conditions. First set of tests included varying the Start Of Injection (SOI) for water to determine an optimized SOI wherein maximum advancement of combustion phasing was obtained. The results of the study revealed that optimum combustion phasing was achieved at 330° bTDC with water injection. At the optimized SOI, the intake temperature of air was varied from 30°C to 90°C to determine the effect of water injection on the combustion phasing and the NOx emissions. Heated intake air increases the knocking tendency of an engine due to increased charge temperature and hence to control knock below certain limits, combustion phasing needs to be retarded. Water injection helps in reduction of charge temperature which enables advancement of combustion phasing. Experimental results show that, with water injection at intake temperature of air at 90°C, the combustion phasing was advanced by 6° CA, fuel conversion efficiency increased by 1.6% compared to the baseline (without water injection) the NOx emissions were reduced by 31% due to the effectiveness of charge cooling, since at higher temperatures more of the latent heat of vaporization from water is utilized to cool the charge.

Aeroelastic Study of the Dynamic Wind Turbine Response to Rapid Pitch-Control Actions

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State-of-the-art wind turbines are designed to generate up to 20 MW, and have rotor diameters of up to 250 m. With growing energy needs, the size of turbine rotors are increasing adding more emphasis on studies surrounding load control methodologies. Pitch control comprises a significant proportion of load-control approaches used in current day wind turbines. In this approach, the blades are rotated about their longitudinal axes to control the aerodynamic loads acting on them. There are various studies on conventional

pitch-control that account for long-term variations in wind loads, but a smaller number of studies on short-term pitch action. This study focuses on the use of rapid pitch-control for handling short-term variations in wind conditions and load fluctuations within one cycle of rotation. We use a numerical model based on a nonlinear adaptive ODE algorithm, which provides a natural way to integrate the various multi-physics aspects of wind turbine dynamics. This includes the control system and the coupled response of the aerodynamics and the structural deformations of the rotor. Numerical results are presented here for an NREL-5MW Reference Wind Turbine rotor subjected to rapid pitch-control actions, and their significance for wind-turbine rotors in general are discussed.

Implementation of Consensus Based Distributed Control in Power Systems Using PSCAD

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With an increase of renewable energy generators like PV and wind generators, being incorporated in existing power systems, a steady shift can be seen in the control methods of power systems from a centralized power grid to smarter and smaller micro grids with more autonomous power sharing. Even though the decentralized control of power systems is more reliable and cost effective but due to the inherent heterogeneous nature of micro grids, accurate power sharing between generators is a common issue which also results in the difficulty of voltage stabilization of the grid. The proposed consensus based algorithm is a solution proposed to overcome this problem and only requires each generator to be aware of and exchange information with directly connected neighboring generators, maintaining the power balance and voltage stability of the entire grid. The proposed method is simulated in PSCAD and its effectiveness is demonstrated using several cases.

Graduate Research Colloquium Banquet

MUB Ballroom Thursday, February 16, 2017 at 6:00 PM

The graduate research colloquium is the largest event hosted by the graduate student government. At this event, everyone involved with the GRC; both planning and participating, help the graduate student government congratulate the graduate students and faculty who receive awards. The awards given at the Graduate Research Colloquium include:

- Dean's Award for Outstanding Scholarship
- Outstanding Graduate Student Teaching Award
- Graduate Student Service Award
- Presentation Awards (1st, 2nd, 3rd place)
- Poster Awards (1st, 2nd, 3rd place)
- Exceptional Graduate Student Scholar Award
- Exceptional Graduate Student Leader Award
- Exceptional Graduate Mentor Award
- Exceptional Staff Member

Awards

Graduate School Awards

The graduate school sponsors three awards to honor students that have committed an extraordinary amount of time to their studies, instructing others or serving their graduate community. This awards include:

Dean's Award for Outstanding Scholarship
This award is given to one graduate student per department in recognition of their academic success in their chosen field.

Outstanding Graduate Student Teaching Award
This award is given to one graduate student per department in recognition of their exceptional ability as a teacher and excellent evaluations from students.

Graduate Student Service Award
This award is given to graduate students nominated by the GSG Executive Board for their outstanding contributions to graduate education at Michigan Tech.

Graduate Research Colloquium Awards

Graduate students participating in the GRC are judged by Michigan Tech faculty based upon the quality of their work and ability to present in a professional manner. The best three oral presentations and the best three posters are granted a certificate of recognition and a cash prize of $300 for 1st place, $200 for 2nd place or $100 for 3rd place.

Graduate Student Government Merit Awards

The GSG sponsors three awards to honor outstanding work by two graduate students and one faculty mentor. The recipients of these awards were nominated by their colleagues, peers and supervisors and reviewed by the GSG Executive Board.

Exceptional Graduate Student Scholar
One graduate student is awarded with a plaque and $300 for their excellence in academic pursuits, performance inside and outside the classroom, research achievements, publications and presentations, and exceptional work ethic.

Exceptional Graduate Student Leader
One graduate student is awarded with a plaque and $300 for their ability to work with others, participation in extra-curricular activities, contribution to their department and graduate student community, collegial attitude and demeanor, and integrity.

Exceptional Graduate Mentor
One faculty member is awarded with a plaque for their collegial and professional excellence, advocacy for graduate students, availability to graduate students, awareness to graduate student opportunities, inter-disciplinary collaboration, and creativity to avail new opportunities to graduate students.

Exceptional Staff Member
One staff member is awarded with a plaque for their service and advocacy for graduate students, availability to graduate students, awareness to graduate student opportunities.

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