November 19, 2014

Dear Research Day Participants,

We would like to welcome you to the 7th Annual College of Engineering Research Day. Our annual symposium is one of the most important events in the College as it brings students and faculty together as one community for the only time in the year to both share and celebrate their latest research. This year, we have over 130 research posters from students encompassing research areas and centers throughout the College. The fact that you are part of an event showcasing the work of students from 67 undergraduate institutions within 23 countries is a testament to the global reputation of our College.

A continuing tradition of Research Day has been our annual recognition of recent fellowship recipients. We are proud of their success and congratulate these students on their prestigious awards (NSF Graduate Research Fellowship Program, American Association of University Women American Dissertation Fellowship, IEEE, ASME, USF Presidential Fellowship, USF Signature Research Fellowship, USF Graduate Student Success, McKnight, etc.).

For the first time, we are spotlighting faculty who have made outstanding contributions in research over the past few years. Our list includes recent NSF CAREER awardees, AAAS fellows, a USF Professor of the Year, a Jefferson Science fellow, a Fulbright Faculty recipient, and Distinguished University Professors. We are also pleased to recognize faculty who have received nationally competitive awards (Cade Museum Prize, NSF Innovation Corps, and VentureWell) to develop novel technologies that have potential for commercialization.

We would like to express our appreciation to the USF Office of Research & Innovation and the Alfred P. Sloan Foundation University Center for Exemplary Mentoring for their financial support as co-sponsors. Additionally, we are grateful for the support provided by our student volunteers and ambassadors from the Society of Hispanic Professional Engineers (SHPE), Society of Women Engineers (SWE), and the National Society of Black Engineers (NSBE).

Finally, we wish to thank our undergraduates, graduate students, faculty mentors, Research Centers, and judges for participating in Research Day. We congratulate everyone on their accomplishments and efforts in advancing the research mission of U-S-F!

Sincerely,

Research Day Organizing Committee 2014
College of Engineering Leadership Team

**Robert Bishop, Ph.D., P.E.**
Professor & Dean

**Rafael Perez, Ph.D.**
Professor & Associate Dean for Academic and Student Affairs

**Jose Zayas-Castro, Ph.D., FIIE**
Professor & Associate Dean of Research
CHEMICAL & BIOMEDICAL ENGINEERING

Venkat Bhethanabotla, Ph.D.
Professor & Chair
Biosensors, Plasmonics, Computational Catalysis, Cardiac Electrophysiology Modeling.

Norma Alcantar, Ph.D.
Associate Professor

J. Carlos Busot, Ph.D.
Professor Emeritus
Reactor design and simulation, Irreversible thermodynamics, and Engineering education.

Scott W. Campbell, Ph.D.
Professor
Solution Thermodynamics, Phase Equilibria, Environmental Monitoring and Modeling, Semiconductor Processing, Engineering Education.

David Eddins, Ph.D.
Interdisciplinary Professor

Robert Frisina, Ph.D., ASA
Professor, Associate Chair, & Director of the Biomedical Engineering Program

Richard Gilbert, Ph.D.
Professor
Biomedical systems, Electrochemotherapy, Instrumentation, Engineering education, and Drug delivery.

Yogi Goswami, Ph.D., AAAS, ASME, NAI, ASES
Distinguished University Professor & Co-Director, Clean Energy Research Center
Energy conversion, Solar energy, Hydrogen energy and Fuels cells, Thermodynamics and Heat transfer, and HVAC.

Vinay K. Gupta, Ph.D.
Professor and Graduate Program Coordinator
Mark Jaroszeski, Ph.D.
Associate Professor
Drug and gene delivery, Electrofusion, Biomedical Instrumentation, and Electrophoresis.

Babu Joseph, Ph.D., AIChE
Professor
Modeling and simulation applied to a wide variety of problems ranging from the production of liquid fuels from biomass to the capture of solar energy using novel photocatalytic systems

Piyush Koria, Ph.D.
Assistant Professor
Tissue engineering, Biomaterials, Drug delivery, Nanomedicine, Protein engineering, and BioMicroelectromechanical systems (BioMEMs).

John Kuhn, Ph.D.
Assistant Professor
Heterogeneous catalysis, Structure and properties of metal and metal oxide nanoparticles, and Electrochemistry.

William E. Lee III, Ph.D., PE
Professor
Biomechanics, Human sensory perception, Biorheology, and Environmental biotechnology.

Christopher Passagila, Ph.D.
Associate Professor
Vision Systems, Neural Signal Processing, Computational Modeling, Retinal Physiology, and Disease.

Anna Pyayt, Ph.D.
Assistant Professor

Alberto A. Sagues, Ph.D., P.E., NACE
Distinguished University Professor
Materials engineering, Corrosion performance of materials for construction and energy applications, Failure analysis and prevention, and Physical metallurgy.

Carlos A. Smith, Ph.D., PE
Professor Emeritus
Automatic process control, Dynamic process modeling, and Process engineering.

Aydin K. Sunol, Ph.D., PE
Professor
System engineering, Supercritical fluid technology, Green engineering, and Product and process design.
Ryan Toomey, Ph.D.
Associate Professor
Material science, Polymer thin films, Hydrogels, Molecularly imprinted materials, and Holographic Polymerization.

Joseph Walton, Ph.D.
Interdisciplinary Professor
Neural bases of age-related hearing loss, brain plasticity following injury, neural coding of complex sounds.
CIVIL & ENVIRONMENTAL ENGINEERING

Manjiker Gunaratne, Ph.D., P.E.
Professor & Chair
Pavement management systems, Pavement design, and Probabilistic methods and reliability.

Nicholas Albergo, PE, DEE, MSCE
Professor of Practice
Domestic and international experience in contamination assessment, degradation and migration analysis, water/wastewater treatment and permitting, and soil & groundwater remedial strategy.

William Carpenter, Ph.D., P.E.
Professor Emeritus
Structural engineering, Optimization, Viscoelasticity, Fracture mechanics, and Adhesive bonding.

Jeffrey A. Cunningham, Ph.D.
Associate Professor
Contaminant fate and transport in the environment, Physical, chemical and biological processes for water treatment, Water resources and water re-use, and Remediation of contaminated soil and groundwater.

Sarina J. Ergas, Ph.D., P.E.
Professor and Graduate Program Director
Environmental biotechnology-bioremediation, Biological air pollution control, Membrane bioreactor systems, Nutrient removal, and Water scarcity.

Stanley C. Kranc, Ph.D., P.E.
Professor Emeritus
Experimental and theoretical fluid mechanics, Numerical analysis, Corrosion of reinforcing steel in concrete, Magnetofluidmechanics and electrohydrodynamics, Transport processes, Multiphase flow and heat transfer, Chemically reacting flow and combustion, and Physics of high temperature gases.

Jian J. Lu, Ph.D., P.E.
Professor
Traffic operations, Intelligent transportation systems, Systems design, Safety, Data acquisition, and Pavement performance modeling.

Qing Lu, Ph.D.
Assistant Professor
Pavement Design, including analysis and preservation, asphalt and asphalt mixes, transportation infrastructure system management and surface technologies for orthotropic steel deck bridges.
James R. Mihelcic, Ph.D., AAEE
Professor, State of Florida 21st Century World Class Scholar
Sustainable development, Green engineering, Global water and sanitation, and Engineering education reform.

Gray Mullins, Ph. D., PE
Professor
Large scale testing, Field instrumentation, Subsurface sensing and characterization, Structural and geotechnical engineering, Instrumentation, Full scale testing of bridges and foundations, Post Grouted Drilled Shaft Design and Construction, Quality Assurance of Drilled Shafts.

Mahmood H. Nachabe, Ph.D., P.E., ASCE
Professor
Subsurface hydrology, fate and transport of chemicals in the vadose zone, Stochastic hydrology, and Uncertainty in distributed models.

Karim Nohra, M.S.
Instructor
Statics, Dynamics, Mechanics of materials, and Engineering education.

Abdul Pinjari, Ph.D.
Associate Professor
Transportation Planning and Travel Demand Modeling, Econometric Modeling of Travel Behavior, Integrated Land-use Travel Demand Modeling, Sustainable Transportation, Freight Transportation, Travel Data Collection, Safety

Steve E. Polzin, Ph.D., P.E.
Transit Research Director, Center for Urban and Transportation Research (CUTR)
Public transportation planning and design, Mobility and accessibility, Policy analysis

Mark Ross, Ph.D., P.E.
Professor
Water resources, Hydrologic hydraulic, and water quality modeling, Surface and groundwater interaction, GIS applications in hydrology, lake and estuary water quality management, and Estuary sediment dynamics.

Amy Stuart, Ph.D.
Associate Professor
Transport and transformation of pollutants in the atmospheric environment, environmental computational modeling, human exposures to air pollutants.
**Alberto A. Sagues, Ph.D., P.E., NACE**  
*Distinguished University Professor*  
Materials engineering, Corrosion performance of materials for construction and energy applications, Failure analysis and prevention, and Physical metallurgy.

**Rajan Sen, Ph.D., P.E., ASCE, ACI**  
*Professor*  
Structural engineering, Bridge design, Dynamics response of structures, Dynamic behavior of piles, and Pre-stressed concrete.

**Daniel Simkins, Ph.D.**  
*Associate Professor*  
Nanomechanics and computational nanomechanics, Computational biomechanics and computational biology, Computational solid and fluid mechanics, Inverse problems in structural dynamics.

**Michael Stokes, Ph.D., P.E.**  
*Instructor*  
Foundation load testing, non-destructive foundation integrity testing, FRP (fiber-reinforced polymer) repair of corroding piles, engineering education.

**Andrés E. Tejada-Martinez, Ph.D.**  
*Associate Professor*  
Finite element methods for fluids, Subgrid-scale parameterizations for large-eddy simulation (LES) of turbulent flows, Novel LES methodologies, and Numerical simulations of turbulence in the ocean and integration with field observations.

**Maya A. Trotz, Ph.D.**  
*Associate Professor*  
Application of chemical principles to the study and manipulation of pollutant behavior (e.g. arsenic) in natural aquatic systems and in engineered processes, Environmental engineering education.

**Daniel H. Yeh, Ph.D., P.E., LEED AP**  
*Associate Professor*  
Membrane and biological processes for water purification and wastewater reclamation, Industrial wastes minimization, and the Remediation of contaminated soils and sediments, Sustainable energy sources and processes, and Ecological engineering.

**Abla M. Zayed, Ph.D.**  
*Associate Professor*  
Materials engineering and mechanical performance of concrete, metals and composites.
Qiong Jane Zhang, Ph.D.
Assistant Professor
Green engineering and sustainable, life cycle assessment water-energy nexus, environmental fate and transport modeling, and water supply and treatment.

Yu Zhang, Ph.D.
Assistant Professor
Air transportation, Transportation network modeling and operations, Transportation economics and planning, Freight transportation, and Transportation Sustainability.
Larry Hall, Ph.D., IEEE, IAPR, AAAS  
Distinguished University Professor & Chair  
Intelligent systems, Machine learning/data mining, Fuzzy logic in intelligent systems, and Artificial intelligence in visual pattern recognition.

William Armitage, Ph.D.  
Associate Professor  
Robotics for challenging environments, Computational Intelligence, Asynchronous logic and systems, Computing Education

Colin Arnold, Ph.D.  
Applied fuzzy logic and computational intelligence, decision-making in uncertain environments, robotics and intelligent autonomous systems, artificial intelligence, expert systems and hybrid systems.

Paul Bao, Ph.D.  
Associate Professor  
Image and Video Processing, Medical Imaging, Pattern Recognition, Multimedia Systems

Ken Christensen, Ph.D.  
Professor & Undergraduate Program Director  
Performance evaluation of computer networks and High-speed packet switch architectures.

Phillip Dumas, M.S.  
Visiting Professor  
Computer Science and Information Technology Education

Abdel Ejnioui, Ph.D.  
Assistant Professor  
Adaptive and distributed reconfigurable architectures, routing and partitioning algorithms in multi-FPGA systems, special-purpose VLSI architectures for object recognition and computer vision, synthesis methods for low power FPGA designs, computer arithmetic on FPGAs for space applications and clockless techniques on reconfigurable architectures, formal modeling and analysis techniques for software-intensive embedded systems

Alessio Gaspar, Ph.D.  
Associate Professor  
Evolutionary Algorithms, Computing Education Research, Computer Assisted Learning, Intelligent Tutoring Systems

Bill Gauvin, Ph.D.  
Instructor I  
Universal Threat Management, Automated Malware Detection and Analysis, Cyber Security
Swaroop Ghosh, Ph.D.
Assistant Professor
Low-power, energy-efficient and robust circuit/system design, Emerging high density memory design, Hybrid integrated systems, Ultra low-power non-silicon nano-electronics and applications.

Federico Giovannetti, M. S.
*Courtesy Assistant Instructor & Enterprise Software Technical Director, Draper Laboratory*
Mobile Data Collection, Mobile Situational Awareness, Mobile Health

Harvey Glass, Ph.D.
Professor Emeritus
Operating systems, Programming languages, and Embedded systems design.

Dmitry Goldof, Ph.D., IEEE, IAPR
Professor and Associate Chair
Motion analysis, Computer Vision, Image Processing & Biomedical Applications, Pattern Recognition

Adriana Iamnitchi, Ph.D.
Associate Professor
Large-scale distributed systems, Grid computing, and Peer – to – peer networks.

Henrick Jeanty, Ph.D.
Instructor
Handwriting & pattern recognition, Image & face recognition, Optical character recognition, and Automatic document handling systems.

Abraham Kandel, Ph.D., IEEE
Endowed Eminent Scholar, Distinguished University Professor, Professor Emeritus
Applied fuzzy logic and computational intelligence, Software testing and productivity, Decision-making in uncertain environments, and Data mining.

Rangachar Kasturi, Ph.D., IEEE, IAPR
*Douglas W. Hood Professor*
Computer vision and pattern recognition, and Document image analysis.

Srinivas Katkoori, Ph.D.
Associate Professor & Graduate Program Coordinator
High level synthesis, Low power synthesis, Radiation VLSI design, and CAD.

Valentina Korzhova, Ph.D.
Visiting Instructor
Computer Vision, Imaging Processing, and Pattern Recognition.

Tina Kouri, Ph.D.
*Instructor and Undergraduate Advisor*
Applied Algorithms, Cheminformatics.
**Miguel Labrador, Ph.D.**  
Professor  
Design and evaluation of transport layer protocols, Wireless Ad hoc and sensor networks, Bandwidth estimation techniques, Location-Based Sensing Systems.

**Jay Ligatti, Ph.D.**  
Associate Professor  
Software security and programming languages.

**Yao Liu, Ph.D.**  
Assistant Professor  

**Luther Palmer, Ph.D.**  
Assistant Professor  
Biomorphic Robotics

**Rafael Perez, Ph.D.**  
Professor, Interim Dean, & Associate Dean of Academics Affairs  
Artificial intelligence, Neutral networks, and Genetic algorithms.

**Matthew Peterson, Ph.D.**  
Courtesy Assistant Professor  
Bioengineering, Patient safety, Mobile Health, Rehabilitation

**Les Piegl, Ph.D.**  
Professor  
Computer-aided design, Geometric modeling, Computer graphics and analysis, and Design of geometric algorithms.

**Xiaoning Qian, Ph.D.**  
Courtesy Assistant Professor  
Genomic Signal Processing, Computational Biology, Biomedical Image Analysis

**Andrew Raij, Ph.D.**  
Courtesy Assistant Professor  
Human-computer interaction, Augmented, Mixed, and Virtual Environments, Information Visualization, Mobile Health, Personal Informatics

**Nagarajan Ranganathan, Ph.D., IEEE, AAAS**  
Distinguished University Professor  
VLSI system design, VLSI design automation power estimation and optimization computer architecture, and Heterogeneous computing bioinformatics.
Dewey Rundus, Ph.D.
Professor Emeritus
Human-computer interaction.

Sudeep Sarkar, Ph.D., AAAS, IEEE, NAI
Professor & Associate Vice President for Research & Innovation
Perceptual organization in single images and multiple image sequences, Biometrics, Gait recognition, Color-texture analysis, and Performance evaluation of vision systems.

Yu Sun, Ph.D.
Assistant Professor
Robotics, Haptics, Computer vision, Human computer interaction (HCI), and Medical robotics.

Ralph Tindell, Ph.D.
Instructor and Undergraduate Advisor
Computer Science Curriculum.

Yicheng Tu, Ph.D.
Associate Professor
Data management, Power-efficient data management systems, and automatic databasetuning, Data stream processing, Peer-to peer networks, and Multimedia databases.

Murali Varanasi, Ph.D.
Emeritus Professor
Coding theory and Computer arithmetic.

Jing Wang, Ph.D.
Instructor
Computer animation, Motion capture, Empirical evaluation, Compute Science Education.

Alfredo Weitzenfeld, Ph.D.
Professor

Yan Zhang, Ph.D.
Instructor
Computer Science Education

Hao Zheng, Ph.D.
Associate Professor
Developing methods to describe digital systems at high abstraction level, and synthesis algorithms mapping those digital systems into the implementation with high performance, low power consumption, robustness, and adaptivity.
ELECTRICAL ENGINEERING

Thomas M. Weller, Ph.D.
Professor and Chair
Planar and electrically-small 3D antennas, development and application of novel microwave materials, additive manufacturing for RF/microwave design, and electromagnetic sensors.

Huseyin Arslan, Ph.D.
Associate Professor
Advanced signal processing techniques at the physical layer, with cross-layer design for networking adaptivity and Quality of Service (QoS) control. UWB, OFDM based wireless technologies with emphasis on WiMAX and IMT-Advanced, and cognitive and software defined radio.

Robert Bishop, Ph.D. ,P.E., AIAA, AAS
Professor and Dean, College of Engineering
Systems theory, guidance and control of aerospace vehicles, and navigation and estimation theory with applications across a broad range of global challenges

Sanjukta Bhanja, Ph.D.
Associate Professor
Analysis of reliability and its trade-off with performance and power, Development of quantum-aware probabilistic belief model for Quantum cellular automata, Magnetic and Molecular cellular automata, and unconventional non-Boolean computing paradigm using inherent properties of the nano-structures.

Larry Dunleavy, Ph.D.
Professor
Microwave and millimeter-wave device, circuit and system design, characterization and modeling.

Lingling Fan, Ph.D.
Associate Professor
Renewable energy source grid integration, modeling and control of energy systems, large-scale power system planning and operation.

Ralph Fehr, Ph.D.
Assistant Professor
Power system planning methods and reliability enhancement techniques, infrastructure design improvements, high-power semiconductor applications at medium voltages, and engineering education reform.

Christos Ferekides, Ph.D.
Professor
Study and development of electronic materials and devices for opto-electronic applications such as solar cells, light emitting diodes, and x-ray detectors.
Nasir Ghani, Ph.D.
Professor
Cyberinfrastructure design, networking, disaster recovery, cloud computing, and cyber-physical systems (integrated power grids).

Richard Gitlin, Sc.D., NAE, NAI, IEEE
State of Florida 21st Century World Class Scholar, Agere Systems Chair, Distinguished University Professor
Wireless signal processing, communications, and networking (4G, cognitive systems, heterogeneous systems, ad-hoc systems, and cross-layer design), broadband networking (quality of service, restoration and reliability, Terabit networks), communications and networking for biomedical applications, bioengineering, Miniature and Anchored Remote Videoscope for Expedited Laparoscopy (MARVEL).

Andrew Hoff, Ph.D.
Professor & Graduate Program Coordinator
Afterglow chemical processing of materials for electronics, sensor, and MEMS applications, Oxide formation on Si & SiC, Diamond processing, Surface Conditioning, Noncontact Corona Kelvin Metrology of electronic materials, Dielectrics, SiC, Corona Ion-Assisted delivery of drugs and DNA to Skin and Tissue, Noncontact voltage and corona characterization of cells and tissue, Contamination monitoring and control in IC Manufacturing, Microsystem and MEMS fabrication, and Integrated Circuit manufacturing and in-line testing.

Vijay Jain, Ph.D.
Distinguished University Professor
Biomedical systems, biomedical imaging and biomedical image processing, Communication systems and networks, Digital image and video processing, VLSI implementations, system on a chip (biosensing, DNA microarrays, opto-electronics, MEMS, digital, analog), and 3-D SOCs.

Chung Seop Jeong, Ph.D.
Instructor
Control systems with specialty in designing resilient, robust, optimal, and adaptive observers and controllers for linear, nonlinear, stochastic, and chaotic systems.

Selcuk Kose, Ph.D.
Assistant Professor
Analysis and design of high performance integrated circuits, monolithic DC-DC converters, and interconnect related issues with specific emphasis on the design and analysis of power and clock distribution networks, 3-D integration, heterogeneous integrated circuits, and emerging circuit technologies such as resistive memories.

Zhixin Miao, Ph.D.
Assistant Professor
Smart grid automation, electrical power system modeling and simulation, microgrid technologies to integrate renewable energy and energy storage, and power markets.
Don Morel, Ph.D.
Professor
Renewable energy, Photovoltaic solar energy with particular emphasis on the development of thin film solar cells of CuInGaSe2, CdTe and CdSe, amorphous Si, and organic materials, Transparent conductors including ZnO, SnO2, ITO, High efficiency thin film tandem solar cells, Photovoltaic device modeling and simulation, Photodetectors, thin film transistors and memory devices, LED's, and x-ray and gamma ray detectors, I-III-VI2 and II-VI materials and devices, Physical vapor deposition including sputtering, evaporation, close space sublimation and scale up to pre-manufacturing.

Wilfredo Moreno, Ph.D.
Professor
System integration by providing “off-the-shelf” hardware/software solutions to industrial application in the areas of Digital Signal Processing, Communications, Industrial Controls, Microelectronics, and Biomedical Engineering and Multimedia Solutions including Voice and Video over IP applied to Distance Learning Solutions.

Salvatore Morgera, Ph.D., AAAS, IEEE
Professor
Wireless networks, biometrics for identity management, and the intersections between communications and information theory and medicine.

Gokhan Mumcu, Ph.D.
Assistant Professor
Electromagnetic theory, computational electromagnetics, THz imaging systems, metamaterials and their applications to small directive radiators and printed miniature antennas.

Andrew Raij, Ph.D.
Assistant Professor
Intersection of Personal Sensing, Computer Graphics, and Human-Computer Interaction, including how wearable sensors, mobile smartphones, virtual reality, and information visualization can enable people to gain insight into and improve aspects of everyday life.

Al-Aakhir Rogers, Ph.D.
Courtesy Professor and Senior Member of Technical Staff, Draper Laboratory
Novel development of optical MEMS sensors

Stephen Saddow, Ph.D.
Professor
Wide-bandgap semiconductor materials for high-field and high-power device applications, specifically SiC for Bio, Nano and MEMS applications.
**Ravi Sankar, Ph.D.**
Professor
Wireless communications, networking, and signal processing and its applications, Resource and mobility managements of wireless cellular, Ad-hoc, and sensor networks, Energy-efficient design and cross-layer optimization, processing, coding, and recognition applications to speech, image, biomedical and other signals and in integrating intelligent techniques including the use of neural networks and fuzzy logic in the simulation, modeling, and design of high performance and robust systems.

**Rudy Schlaf, Ph.D.**
Professor

**Lee (Elias) Stefanakos, Ph.D.**
Professor & Co-Director of Clean Energy Research Center

**Arash Takshi, Ph.D.**
Assistant Professor & Director of Undergraduate Research, College of Engineering
Bio and Organic electronic devices, particularly in photovoltaic devices.

**Sylvia W. Thomas, Ph.D.**
Assistant Professor
Advanced materials for alternative energy sources, sustainable environments, aerospace, and bio-applications from the micro to the nano scale, characterizing, modeling, and integrating materials that demonstrate high levels of biocompatibility, thermal reflectivity, mechanical robustness, and environmental sustainability, such as carbides, sol-gel coatings, high temperature oxides, and mucilage.

**Ismail Uysal, Ph.D.**
Assistant Professor
Applications of wireless and radio frequency identification (RFID) technologies to supply chain for food and pharmaceuticals, remote environmental modeling, adaptive algorithms for smart sensory data processing and other auto-ID systems..

**Jing Wang, Ph.D.**
Associate Professor
Nano/microfabrication, Nanomaterials, RF MEMS devices, On-chip power generation, Microfluidics, MEMS transducers, RF integrated circuit, Wide bandgap materials, Polymer nanocomposite, and Responsive polymers.
Paris Wiley, Ph.D.
Associate Professor & Associate Chair
INDUSTRIAL AND MANAGEMENT SYSTEMS ENGINEERING

Tapas K. Das, Ph.D., IIE
Professor and Chair
Modeling of decision making problems in interdisciplinary fields including restructured electric power markets with emissions restrictions, large-scale pandemic outbreak impact mitigation, and cancer diagnosis and prevention.

Patricia Anzalone, Ph.D.
Instructor & Engineering Management Program Coordinator
Manufacturing and services systems, Application in medical devices and pharmaceutical industries, Multivariate quality control, and Statistical analysis.

Griselle Centeno, Ph.D.
Associate Professor
Applied operations research, Scheduling, Decision making, Capacity planning modeling for transportation, Manufacturing, and Healthcare Systems.

Susana Lai-Yuen, Ph.D.
Associate Professor
Computer-aided design (CAD), Computer-aided molecular design (CAMD), Nanotechnology, Human- computer haptic interfaces, and Computational geometry for design and manufacturing.

Geoffrey Okogbaa, Ph.D.
Professor
Reliability, Maintainability, Engineering design, Automated manufacturing systems, and Quality Control.

Kingsley Reeves, Ph.D.
Associate Professor
Supply chain management, Organizational structure, Collaborative networks, and Managerial decision making in outsourcing.

Alex Savachkin, Ph.D.
Associate Professor & Graduate Program Coordinator
Analytical support of enterprise risk management, Health care engineering, Public health disaster mitigation, and Cancer care engineering.

Paul Schnitzler, Ph.D.
Instructor
Management of technological change motivation, and the development of individual creativity for the benefit of organizations.
**Michael Weng, Ph.D.**  
*Associate Professor*  
Computer numeric methods, Production control, Operations research, and Material resource planning.

**Ali Yalcin, Ph.D.**  
*Associate Professor*  
Discrete event systems modeling, Analysis and control, and Manufacturing information systems.

**Hui Yang, Ph.D.**  
*Assistant Professor*  
Healthcare informatics, Nonlinear dynamics, Sensor based modeling and analysis, Reliability, and Statistical quality control.

**Jose Zayas-Castro, Ph.D., IIE**  
*Professor & Associate Dean for Research*  
Enterprise change reengineering, Engineering the service sector, Productivity improvement applied to service and manufacturing enterprises, Entrepreneurship, Applied statistical analysis, Economic/cost analysis and systems dynamics student learning curricular development and assessment.

**Bo Zeng, Ph.D.**  
*Assistant Professor*  
Discrete and combinatorial optimization, and Data mining and their applications in medical decision making and healthcare systems.
MECHANICAL ENGINEERING

Rajiv Dubey, Ph.D., ASME
Professor & Chair
Design, simulation and testing of haptic interfaces and assistive devices for persons with disabilities, Rehabilitation engineering, Smart prosthetics and orthotics, Robotic/telerobotic applications in healthcare, space, undersea, and nuclear waste management, and Dynamic systems and controls.

Glenn Besterfield, Ph.D.
Associate Professor & Executive Director, INTO USF
Finite Element Analysis, Computational Mechanics, Mechanical Design, Bascule bridges.

Stephanie Carey, Ph.D.
Assistant Research Professor
Motion analysis, Rehabilitation engineering, Biomechanics, Prosthetic design.

Wenjun Cai, Ph.D.
Assistant Professor
Metallurgy, Mechanical behavior, Nanomaterials, Materials Characterization, Tribology.

Nathan Crane, Ph.D.
Associate Professor
Micro and Nanoscale assembly, Additive manufacturing/rapid prototyping processes, Manufacturing, Machine design, and Thermal protection systems for hypersonic flight.

Don Dekker, Ph.D.
Adjunct Professor
Engineering design processes, and Engineering education.

John Dixon, Ph.D.
Instructor

Delcie Durham, Ph.D., SME
Professor and Graduate Program Coordinator
Sustainable manufacturing, Predictive product realization, Fundamental methods for complex systems, and Interdisciplinary research organizational models.

Jonathan Gaines, Ph.D.
Instructor

Nathan Gallant, Ph.D.
Assistant Professor
Biomechanics, Cell adhesion, Biomaterials, Tissue engineering, Surface functionalization, and Micropatterning.
Rasim Guldiken, Ph.D.
Associate Professor
Bio-MEMS sensor design and fabrication, Micro-fluidics, Ultrasonic imaging, Micromachined ultrasonic transducer design, Ultrasonic cleaning and Non-destructive testing.

Daniel Hess, Ph.D.
Professor
Dynamics of mechanical & structural systems with friction, Machinery dynamics & diagnosis, and Mechanical design.

Autar K. Kaw, Ph.D., ASME
Professor
Engineering education research, Mechanics of composite materials, Elasticity, Fracture, Thermal stresses, Graphic user interfaces for engineering problems, and Web based course development.

Ashok Kumar, Ph.D., ASM, AAAS
Professor
Thin film technology for multifunctional applications, Processing, characterization, and applications of nanomaterials, Reliability issues in microelectronics and MEMS devices, Sensor technology, Novel materials for energy applications, Analytical techniques of thin films and surfaces.

Craig Lusk, Ph.D.
Associate Professor
Compliant mechanisms, MEMS design, Biomechanics, and Theoretical kinematics.

Ajit Mujumdar, Ph.D.
Instructor
Engineered and functionalized active pharmaceutical ingredients (APIs) by dry coating technique, Magnetically assisted impaction mixing of nano-size particles, Discrete element model based numerical simulation of agitator.

Jose Porteiro, Ph.D.
Professor
Fluid dynamics, Heat transfer, Separated flows, and Experimental techniques.

Frank Pyrtle III, Ph.D., P.E.
Instructor
Two-phase heat transfer, Droplet and spray cooling, Micro/nano scale heat transfer, and Microelectronic device thermal management
Kyle Reed, Ph.D.
Assistant Professor
Rehabilitation engineering, Haptics, Human-machine interaction, Medical robotics, and Engineering education.

Alex Volinsky, Ph.D.
Associate Professor
Thin films processing, Mechanical properties and characterization, Adhesion and fracture of thin films, Nanoindentation, Irradiated materials properties and X-Ray diffraction.

Stuart Wilkinson, Ph.D.
Associate Professor
Advanced interdisciplinary systems design.

Shuh Jing Benjamin Ying, Ph.D.
Professor Emeritus
### College of Engineering Research Centers

<table>
<thead>
<tr>
<th>Center Name</th>
<th>Description</th>
<th>URL</th>
</tr>
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<tbody>
<tr>
<td><strong>1 Center for Assistive and Rehabilitation Robotics Technologies (CARRT)</strong></td>
<td>This Center incorporates innovative theory and state-of-the-art facilities to develop rehabilitation robotics technologies.</td>
<td><a href="http://carrt.eng.usf.edu/">http://carrt.eng.usf.edu/</a></td>
</tr>
<tr>
<td><strong>2 Center for Communications and Signal Processing (CCSP)</strong></td>
<td>This Center promotes research and development in the transport of information on electronic photonic media; networking of intelligent systems; and processing of signals, images and video.</td>
<td><a href="http://ccsp.eng.usf.edu/">http://ccsp.eng.usf.edu/</a></td>
</tr>
<tr>
<td><strong>3 Center for Digital and Computational Video (CDCV)</strong></td>
<td>This Center provides a focal point for multidisciplinary research and education in a broad spectrum of digital and computational video.</td>
<td><a href="http://cdcv.eng.usf.edu/">http://cdcv.eng.usf.edu/</a></td>
</tr>
<tr>
<td><strong>4 Center for Urban Transportation Research (CUTR)</strong></td>
<td>CUTR is a nationally recognized center of excellence in transportation issues.</td>
<td><a href="http://www.cutr.usf.edu/">http://www.cutr.usf.edu/</a></td>
</tr>
<tr>
<td><strong>5 Center for Wireless and Microwave Information Systems (WAMI)</strong></td>
<td>Research done here is advancing the state of knowledge in the wireless and microwave field.</td>
<td><a href="http://wami.eng.usf.edu/">http://wami.eng.usf.edu/</a></td>
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<td><strong>6 Clean Energy Research Center (CERC)</strong></td>
<td>This Center investigates Florida’s abundance of solar and biomass resources for use as environmentally clean sources of power.</td>
<td><a href="http://cerc.eng.usf.edu/">http://cerc.eng.usf.edu/</a></td>
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<td>7</td>
<td>Nanotechnology Research and Education Center (NREC)</td>
<td>Research at the NREC deals with diverse fields of nanoscience such as new materials, molecular nano-electronics, nano-electroptics, nano-medicine and nano-biology. URL: <a href="http://www.nrec.usf.edu/">http://www.nrec.usf.edu/</a></td>
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<td>8</td>
<td>Global Center for Hearing and Speech Research (GCHSR)</td>
<td>Research at GCHSR focuses on developing novel interventions and treatments for different types of sensory deficits. URL: <a href="http://www.gchsr.usf.edu/">http://www.gchsr.usf.edu/</a></td>
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<td>9</td>
<td>Center for Modeling Hydrologic and Aquatic Systems</td>
<td>Assists in the solution of water resource problems for local, state and federal governmental agencies, often working closely with or directly for private consulting firms with particularly challenging or specialized investigations. URL: <a href="http://cmhas.eng.usf.edu/">http://cmhas.eng.usf.edu/</a></td>
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<td>10</td>
<td>National Bus Rapid Transit Institute</td>
<td>Facilitating the sharing of knowledge and innovation for increasing speed, efficiency, and reliability of high-capacity bus service through the implementation of BRT systems in the United States. URL: <a href="http://www.nbtti.org/">http://www.nbtti.org/</a></td>
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<td>11</td>
<td>Center for Applied Research in Medical Devices (CareMed)</td>
<td>The mission of CareMed is to improve the overall effectiveness of the medical devices and equipment (MDE) industry across its entire value chain. URL: <a href="http://caremed.eng.usf.edu/">http://caremed.eng.usf.edu/</a></td>
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<td>12</td>
<td>USF Center for Entrepreneurship</td>
<td>The USF Center for Entrepreneurship is a nationally-ranked, multidisciplinary, campus-wide center focusing on entrepreneurial education, training, and research. URL: <a href="http://entrepreneurship.usf.edu/">http://entrepreneurship.usf.edu/</a></td>
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| 13 | **National Center For Transit Research** | NCTR’s goal is to make public transportation and alternative forms of transportation, including managed lanes, safe, effective, efficient, desirable, and secure.  
URL: http://www.nctr.usf.edu/ |
| 14 | **Functional Materials Research Institute** | Provides summer materials-related research experiences for community college, high school, and pre-service STEM teachers.  
URL: http://fmri-ret.eng.usf.edu/ |
College of Engineering Graduate Fellowship Recipients

**NSF Graduate Research Fellowship Program (GRFP)**
Suzanne Boxman (Honorable Mention)
Laura Byrnes-Blanco
Shamara Collins
Joel Cooper
Pablo Cornejo-Warner (Honorable Mention)
Matt Verbyla

**NSF East Asian Pacific Summer Institute Fellowship**
Adrian Johnson

**NASA Space Technology Research Fellowship (NSTRF)**
Drew Burgett

**NASA Harriett Jenkins Predoctoral Fellowship Program**
Innocent Udom

**UNCF Merck Graduate Science Dissertation Fellowship**
Olukemi Akintewe

**UNCF Gates Millennium Scholarship (GMS)**
Dagmara Monfort

**Draper Laboratory Fellowship (DLF)**
Tylar Murray

**American Association of University Women (AAUW) American Dissertation Fellowship**
Colleen Naughton

**National Institutes of Health/National Institute of Aging Research Supplement to Promote Diversity in Health Related Research Award**
Jeanine Mansour
Tanika Williamson

**IEEE Microwave Theory, Techniques, Society (IEEE-MTTS) Fellowship Programs**
Michael Grady

**USF Presidential Fellowship**
Jayita Das
Arseny Zhdanov

**ARFTG Microwave Measurement Student Fellowship Program**
Maria Cordobo Erazo

**IEEE Antennas and Propagation Society Doctoral Research Award**
Ahmad Gheethan
College of Engineering Graduate Fellowship Recipients

National Consortium for Graduate Degrees for Minorities in Science and Engineering (GEM) Fellowship
Michael Grady
Alisha Peterson

Florida Education Fund’s McKnight Doctoral Fellowship Program
Olukemi Akintewe
Veronica Aponte-Morales
Vinicio Carias
Shamara Collins
Mutasim El-Sheikh
Dagmara Monfort
Pablo Cornejo-Warner
Michael Grady
Maritza Muniz-Maisonet
Alisha Peterson
Issa Ramirez
Mark Santana
Christopher Slater
Innocent Udom

USF Graduate Student Success Fellowship
Vinicio Carias
Yolanda Daza
Laura Rodríguez-Gonzalez
Innocent Udom
Nada Elsayed
Mandek Richardson

USF Signature Research Fellowship
Pacia Hernandez
Maureen Kinyua

Alfred P. Sloan Minority Ph.D. Fellowship Program
Olukemi Akintewe
Veronica Aponte-Morales
Edikan Archibong
Nellie Bonilla
Pablo Cornejo-Warner
Pacia Diaz
Mutasim El-Sheikh
Nicole Febles
Alisha Peterson
Laura Rodriguez-Gonzalez
Tamina Johnson
Issa Ramirez
Mandek Richardson
Jose Fernandez
Michael Grady
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Innocent Udom
Samuel Perez
Amine Hafsi
Rafael Rodriguez
Mark Santana
Eric Tridas

NSF Florida-Georgia Louis Stokes Alliance for Minority Participation Bridge to the Doctorate
Olukemi Akintewe
Edikan Archibong
Vinicio Carias
Shamara Collins
Francesca Moloney
Pablo Cornejo-Warner
Nicole Febles
Tamina Johnson
Raul Iglesias
Alisha Peterson
Issa Ramirez

U.S. Department of Education Graduate Assistance in Areas of National Need (GAANN) Fellowship
Brian Bell
Ivy Cormier
Matthew Earle
Ryan Locicero
Mark Santana
Jamie Trahan

U.S. Student Fulbright Research Grant Scholarship
Vinicio Carias

WEF Canham Graduate Studies Scholarship
Ryan Locicero

American Society of Mechanical Engineers (ASME) Graduate Teaching Fellowship
Jamie Trahan
College of Engineering Graduate Fellowship Recipients

NSF Scholarships in Science, Technology, and Engineering, and Mathematics (S-STEM)
Robert Bair
Maria Briones
Cherise Burton
Suzanne Boxman
Jorge Calabria
George Dick
Oswaldo Galicia
Greg Hinds
James Libby
Ryan Locicero
Nathan Manser
James Murduca
Colleen Naughton
Christine Prouty
John Pryor
Laura Rodriguez-Gonzalez
Ann Sager
Lorena Sanchez
Kelly Vannoy
Brian Wells
7th Annual USF College of Engineering Research Day
USF Marshall Student Center Ballroom
Wednesday, November 19, 2014

AGENDA

8:00 a.m. to 8:45 a.m.
Poster Setup (USF Marshall Student Center – MSC)

9:00 a.m.
Opening Remarks
Jose Zayas-Castro, Ph.D., IIE
Professor & Associate Dean for Research
College of Engineering

Welcome
Robert H. Bishop, Ph.D., P.E.,
Professor & Dean
College of Engineering

Presentation of Student Awards
Dr. Robert H. Bishop, Professor & Dean

10:00 a.m. to Noon
Poster Viewing/Judging

Noon to 1:30 p.m.
Lunch (USF Marshall Student Center - MSC)

1:30 p.m. to 2:00 p.m.
Closing Remarks
Paul Sanberg, Ph.D., D.Sc., AAAS
Senior Vice President for Research & Innovation
President, USF Research Foundation
Distinguished University Professor

2:00 p.m.
Poster Breakdown (USF Marshall Student Center - MSC)
Opening Remarks

**Jose Zayas-Castro, Ph.D.,** is a Professor and Associate Dean for Research in the College of Engineering at the University of South Florida. In 2002, he joined USF as a Professor and Chair of the Department of Industrial & Management Systems Engineering (IMSE). He received his Bachelor of Science degree in Industrial Engineering in 1978 from the University of Puerto Rico – Mayaguez. In 1979 he received a Masters of Science degree in Industrial and Management Engineering from the Rensselaer Polytechnic Institute (RPI) and an MBA in 1981 from RPI. He received his Doctorate in Management from RPI in 1981. His research interests are in Healthcare Systems Engineering, Economic and Cost Systems, Manufacturing and R&D strategy. Dr. Zayas-Castro also serves as a Research Associate with the James A. Haley VA Hospital and as a Member at the H. Lee Moffitt Research Institute and Cancer Center, both in Tampa, FL.

During his career, Dr. Zayas-Castro has advised/mentored almost a dozen PhDs, 30 MS, and over 25 undergraduate research students. More than 80% of them underrepresented students. In addition he has been an active committee member of 36 MS students and 16 doctoral students, including one in Chile, S.A.; more than 50% of them being underrepresented students. He has been an invited speaker to several universities, professional and national forums and workshops on aspects related to increasing the participation of underrepresented students in STEM, mentoring potential faculty among underrepresented doctoral students and increasing the participation of undergraduate underrepresented students in REU programs. In his tenure at the University of Puerto Rico-Mayaguez (UPRM) he worked very actively with undergraduate students to help them pursue Ph.D.s in outstanding programs in the continental US. While Department Head at IE (1987-90) he initiated efforts to systematically mentor and advice undergraduates to pursue graduate degrees and help them to seek opportunities for fellowships and scholarships. While Department Head at IE (1987-90) he initiated efforts to systematically mentor and advice undergraduates to pursue graduate degrees and help them to seek opportunities for national fellowships and scholarships. Dr. Zayas-Castro established the Learning Factory at UPRM and has adapted Learning Factory concepts to other U.S. universities. In 1999, he implemented the Entrepreneurial Manufacturing Innovation Learning Experience Program at the University of Missouri-Columbia, and at USF, he has redesigned the capstone project to include elements of the Learning Factory.

Dr. Zayas-Castro has been awarded 2009 INFORMS Moving Spirit Award, the 2006 USF Hispanic Pathways Award, the 2006 HENAAC Education Award – University, and the 2005 UPS- IIE Minority Advancement Award. He is a member of NSBE and SHPE, and has been advisor of NSBE and SHPE student Chapters.
Welcoming Remarks

Robert H. Bishop, Ph.D., P.E., is the sixth dean of the College of engineering at the University of South Florida. Dean Bishop is a specialist in the applications of systems and control theory to modern engineering products.

Bishop’s current research involves development of advanced spacecraft navigation methods and he has initiated several non-satellite projects. He was selected twice as a Faculty Fellow at the NASA Jet Propulsion Laboratory and as a Welliver Fellow of the Boeing Company to work with their business unites to learn about connecting industry needs with educating the next generation of engineers. He is the co-author of one of the world’s leading undergraduate textbooks in control theory and has authored two other textbooks, edited two handbooks, and authored/co-authored over 125 journal and conference papers.

Bishop was selected to lead Marquette’s engineering college in 2010 after previously working as a professor and department chair at The University of Texas at Austin. Before then, he was a practicing engineer at Draper Laboratory – the Massachusetts Institute spinoff that has played a historically significant role in the U.S. space program – where he developed an international reputation as a leading specialist in guidance, navigation and control of aerospace vehicles.

Bishop earned his Ph.D. (1990) at Rice University in Electrical and Computer Engineering, his M.S. (1980) and B.S. (1979) in Aerospace Engineering at Texas A&M University. He is a Fellow of the American Institute of Aeronautics and Astronautics and a Fellow of the American Astronautical Association.
Closing Remarks

Paul Sandberg Ph.D., D.Sc. is Senior Vice President for Research & Innovation, Distinguished University Professor. Dr. Sanberg trained at York University, the University of British Columbia, the Australian National University and Johns Hopkins University School of Medicine, among others. Before coming to USF, Dr. Sanberg held academic positions at Ohio University, the University of Cincinnati, and Brown University.

Prior to his current position, Dr. Sanberg served as Associate Dean in Morsani College of Medicine, Associate Vice President in USF Health, Senior Associate Vice President for the Office of Research & Innovation and Special Assistant to the President all at USF.

Dr. Sanberg is a member of the Board of Scientific Counselors for the National Institute of Drug Abuse at the National Institutes of Health, and has served on numerous scientific advisory boards for health-related foundations and companies. He has significant industry experience with biotech companies involved in cell therapy for degenerative disorders and biopharmaceutical development. He is the Editor-in-chief of Technology and Innovation, and serves on editorial boards for more than 30 scientific journals. Dr. Sanberg is the President of the National Academy of Inventors and has also served as president of a number of professional societies including the American Society for Neural Transplantation and Repair, the Cell Transplant Society, and the International Behavioral Neuroscience Society. He is the author of more than 600 scientific articles, including thirteen books, with over 20,000 scientific citations (Google scholar).

As an inventor on approximately 100 health-related U.S. and foreign patents, his early work was pioneering in understanding why brain cells die in neurological disorders and in drug abuse research. His recent research has focused on discovering innovative ways to repair the damaged brain, and has helped lead the team that demonstrated that bone marrow and umbilical cord blood derived stem cells can be transformed to neural cells that may be useful in stroke, spinal cord injury and ALS. Dr. Sanberg’s work has been instrumental in translating new pharmaceutical and cellular therapeutics to clinical trials for Tourette syndrome, depression, stroke, Huntington’s disease and Parkinson’s disease. He is a Fellow of the AAAS, a Charter Fellow of the National Academy of Inventors, and serves on the evaluation committee of the National Medal of Technology and Innovation.
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## Research Category # 1
**ENERGY, SUSTAINABILITY, WATER AND INFRASTRUCTURES/TRANSPORTATION**

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Research Category # 1: Energy, Sustainability, Water and Infrastructures/Transportation
Environmental and Economic Sustainability of Ion Exchange Drinking Water Treatment Plants in Florida

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Keywords: drinking water treatment, sustainability, energy usage, ion exchange, economic analysis, life cycle assessment

Existing water treatment infrastructure faces numerous operational and financial challenges with over one fourth of all potable water systems in the U.S. being in violation of EPA or state rules in 2009. Ion exchange (IX) is a water treatment technology that can be used to remove various types of contaminants in drinking water. Operational advantages are provided by its scalability, ability to remove a wide range of contaminants, operate intermittently or continuously, perform under varying water chemistry, and use different reactor configurations at different locations in a treatment train. Therefore, it may be an ideal choice for small PWS and has shown increased adoption in Florida in recent years to remove organics from drinking water to meet new disinfection by-product (DBP) regulations. However, literature on the sustainability of IX systems is extremely sparse and life cycle assessment (LCA) studies for most IX applications have not been performed and life cycle cost analyses (LCCA) have not been completed on drinking water treatment plants that use IX.

This study utilizes LCA and cost analysis to holistically evaluate environmental, human health, and economic impacts of IX technology that is used for reduction of organics and DBPs in drinking water treatment plants in Florida. Differences in water quality were found to have significant effects on the environmental impact of the systems. Furthermore, preliminary impact assessment results show that the construction phase has negligible environmental impact in comparison to the operation phase. Tradeoffs also exist between systems that use fixed bed reactors (FBR) with conventional resin and completely mixed flow reactors (CMFR) using Miex resin. FBR systems have higher salt usage, transport requirements, and brine waste, but use overall less electricity and resin. This tradeoff causes FBR systems to have a higher overall environmental impact but lower operation cost. Environmental impacts were also found to increase linearly at small scale but then decrease as scale increases above 2 MGD, challenging previous assumptions about the relationship between environmental impact and scale.
Anaerobic membrane bioreactor (AnMBR) for decentralized sanitation and resource recovery

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Keywords: Anaerobic membrane bioreactor, AnMBR, decentralized sanitation

Decentralized wastewater treatment has the potential of minimizing many of the health and environmental impacts associated with faecal sludge collection and transportation experienced in developing countries. However, many of the existing onsite treatment technologies are low tech and can only guarantee pathogen destruction under optimal conditions. In-ground solutions such as latrines or septic tanks are also prone to failure from flooding. This study investigates the use of an anaerobic membrane bioreactor (AnMBR) for onsite treatment and water reuse. AnMBRs have already gained traction within the industrial wastewater treatment sector because of their ability to handle high-strength effluents and their ability to generate high-quality permeate. Yet, their application to domestic wastewater treatment remains limited. The ability to use AnMBRs in a range of wastewater strengths was investigated in this study. To further decrease the energy requirements of the system, the biological effects of withholding external heating was also investigated.

For this study, a pilot-scale 20.45 litre AnMBR with external PVDF tubular membranes was operated for a total of 365 days. The AnMBR was operated at ambient temperatures while treating domestic wastewater at a school, spiked with additional organic carbon to various COD concentrations to mimic wastewater from domestic buildings, water-efficient buildings, public toilets and low-strength wet faecal sludge pits. The average total COD removal efficiency was 89.4% across all incoming wastewater strengths, with the higher feed strengths having COD removal efficiencies above 95%. The design membrane flux was established at 4 LMH to ensure adequate long term performance. The reactor pH and alkalinity remained stable despite large fluctuations in feed concentrations and ambient temperatures. Onsite treatment of wastewater can be reliably accomplished with the use of AnMBRs which are better suited to higher strength wastewaters. Higher strength wastewaters have higher removal efficiencies and require less membrane throughput for the same number of end users. AnMBRs also allow for the retention of organics within the reactor even during times when microbial activity is low, which allows for the microbial degradation when the conditions improve for microbial activity.
Comparison of LED and HPS Street Lighting on Visibility Performance to Drivers and Pedestrians in Selected Corridors

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Keywords: Transportation, LED, HPS, Visibility

As our oil and gas reserves decrease and the demand for energy increases, energy conservation has been an urgent priority. Using energy-efficient technology is required in roadways to mitigate the effects of the energy crisis. Currently, there is an alternative to our High Pressure Sodium (HPS) street lighting we see every day. LED lighting provides an improved overall visibility in roadways despite footcandle reductions. Our objective is to compare the footcandles and visibility performance of LED and HPS to drivers and pedestrians in selected corridor using qualitative and quantitative methodologies.
Towards a sustainable future: Encapsulation of High Temperature Thermal Energy

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Keywords: Thermal Energy Storage, Sustainability, Phase Change Materials (PCMs), Metallic Encapsulation

Development of high temperature thermal energy storage is crucial in order to achieve a sustainable future. In addition to making solar energy more competitive, it would also improve the capacity factor of operating thermal power plants by reducing the erratic nature of energy demand and supply.

This poster presents the results of thermal cycling of a PCM in a metallic encapsulation up to a temperature range of 680°C. The NaCl-KCl eutectic PCM (melting pt. 657°C) encapsulated had favorable thermo physical properties in terms of melting point and latent heat. However, it suffered from low thermal conductivity and was corrosive. To counter these disadvantages, a metallic encapsulation was used to improve the thermal conductivity of the PCM. Furthermore, a procedure was employed to seal the encapsulation under inert conditions. This approach proved to be effective in successfully encapsulating this high temperature PCM. This metallic encapsulation has survived more than 3000 hours in air at elevated temperatures (500°C-680°C).
An evaluation of hydroponic vegetable growth and nitrate concentration in a marine, bench-scale aquaponic system

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Keywords: Aquaponics, hydroponics, expanded clay, coconut fiber, sea purslane

Aquaponics is the practice of growing fish and plants symbiotically in a recirculating aquaculture system. The addition of hydroponic plant production improves the efficiency of water use and eliminates discharge of nutrients to the environment. Freshwater aquaponic systems are commonly used to produce tilapia and vegetables such as lettuce. This research explores the novel combination of a saltwater fish and saltwater vegetable. Twelve bench-scale aquaponic systems were constructed at Mote Aquaculture Research Park located in Sarasota, FL.

The systems were used to conduct a series of experiments on the impact of support media, plant presence, plant density and flow rate on plant growth and nitrate concentration. The fish tanks were stocked with mollies (Poecilia sp.) and either sea purslane (Sesuvium portulacastrum) or saltwort (Salicornia sp.). Ammonia (NH₄⁺), nitrite (NO₂⁻), and nitrate (NO₃⁻) were measured twice weekly. Plant weights were determined at the start and end of the study. Preliminary results indicated that the support media coconut fiber results in lower nitrate concentrations than expanded clay. The results also indicate that a lower flow rate and higher plant density contribute to lower nitrate concentrations. The information collected from these experiments will be used in the operation of a large-scale marine aquaponic system also at Mote Aquaculture Research Park.
Wastewater Nutrient Recovery Using Anaerobic Membrane Bioreactor (AnMBR) Permeate for Hydroponic Fertigation

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Keywords: anaerobic membrane bioreactors (AMBR), controlled environment agriculture (CEA)

The imbalance between global population growth and resource consumption is indicative of unsustainable practices and foreshadows a grim future of continued resource depletion, food and water scarcity, social inequality, and deteriorating public and environmental health. Meanwhile, the urban centers of the world continue to experience exponential growth resulting in overwhelmed food, water, and sanitation infrastructure. Decentralized and satellite wastewater treatment technologies capable of resource recovery, such as anaerobic membrane bioreactors (AnMBR), foster synergistic opportunities to help manage the food, energy, and water sectors of urban environments. Specifically, the nutrient concentration and high effluent quality of permeate produced by AnMBR systems present applicability in controlled environment agriculture (CEA).

The efficacy of AnMBR permeate is evaluated in a hydroponics growth study of cucumber (Cucumis sativus) grown in an outdoor greenhouse and tomato (Lycopersicon lycopersicum) grown indoors. Nutrient analysis of permeate generated by a small, pilot scale AnMBR developed for the treatment of domestic wastewater at ambient temperature indicated sufficient concentrations of N and P elements, however high proportion of NH4+ in N species decreased growth performance. Opportunities for optimizing AnMBR permeate for hydroponics applications exist and thus imply synergistic integration of decentralized AnMBR technology with controlled-environment agriculture (CEA) such as hydroponics. A model is proposed for the integration of decentralized AnMBR and CEA systems capable of producing usable plant products within the urban environment. The integration of these systems is proposed as a solution to the challenges of with food security, stressed water supplies, and environmental degradation associated with unchecked urban growth in the developing and developed world.
Biodiesel Production by Supercritical Transesterification

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Keywords: Biodiesel, Supercritical, Transesterification, Sustainable

A novel sustainable biodiesel manufacturing process has been developed. The continuous process produces biodiesel from waste oils and waste alcohols collected from the local community. It aims at powering the University bus system using a portable plant with a capacity of several hundred thousand gallons a year. The process is intensified by utilizing supercritical alcohols in transesterification reactions with residence times of a few minutes and minimal separation requirements compared to conventional biodiesel production methods. Moreover, the process is very tolerant to water in the waste oil, unlike the conventional alternatives, and incorporates heat integration to minimize utility requirements. Although alcohol cost is minimal, efforts to utilize alcohol waste from University hospitals and laboratories is expected to further reduce the cost of raw materials and boost the sustainability of the technology. With this intensified process wastewater generation is virtually eliminated compared to conventional production methods, which generate 30 gallons of wastewater for every 100 gallons of biodiesel produced. The glycerol by-product is significantly purer than that from conventional methods and can serve as precursor in high-value pharmaceuticals production or soap production for local use.

An orthogonal experimental design has been implemented to identify the effects of important process variables, including reaction temperature, residence time, and molar ratio of alcohol to oil. The temperature of operation ranges from 250 C to 350 C and the pressure from 1,500 to 2,000 psia, while the excess alcohol is about 2-8 times the stoichiometric amount and is recycled. Moreover, optimal conditions have been identified by means of response surface methodology. The biodiesel yield is determined by ester content, which is measured via gas chromatography. The presentation will report on the pilot plant operation, process scale up, transportation system powering implications, and life cycle considerations.
**Impact of Thermal Pretreatment on Varying Substrates Biogas Production in an Anaerobic Digesting System**

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**Keywords:** Swine Manure, Algae, Biogas Production, Methane Yield, Biological Methane Potential

There is a growing desire to utilize the process of Anaerobic Digestion in order to break down different substrates and produce biogas. Anaerobic digestion (AD) is a sustainable alternative to stabilize the waste and produce methane that can be utilized as an onsite energy resource. A growing demand for swine meat has resulted in an increase of concentrated animal feeding operations (CAFO). These operations produce a surplus of nitrogen and phosphorous which causes eutrophication to occur in the environment. The pathogens from manure are also harmful to public health. Algal pond is a low cost and environmental friendly method to treat swine waste. The harvested algae can be co-digested with swine manure for energy production. However, the gas yield of algae is low due to the thick cell wall. Thermal pretreatment is a process used to solubilize organic particulate matter in order to increase the hydrolysis step of anaerobic digestion and increase biogas yields. The purpose of this study was to investigate the impact of different thermal pretreatment conditions on biogas production in an anaerobic digester using Swine Manure (SM) and Swine Manure & Algae.

Two separate experiments were used to carry out this study; the first experiment consisted of pretreating swine manure at 70°C, 90°C and 121°C. In order to determine the pretreatment time, hydrolysis tests were performed at each temperature with treatment times varying. A time of 30 minutes was chosen for 70 °C and 90 °C, and 20 minutes for 121°C because it resulted in the highest increase of hydrolysis efficiency. Once the pretreatment was performed, batch reactors were setup in order to measure the biological methane potential (BMP) over the course of a 15-day period.

Thermal pretreatment of SM&A under 121°C for 20 minutes resulted in the highest biogas yield. Thermal pretreatment of SM and SM&A at 70°C showed higher gas yield than pretreatment at 90 °C. The methane yield and biogas production did not increase significantly compared to the untreated samples perhaps due to the low microbial activity. Semi-continuous operation of these substrates is currently conducted to acclimate microbial community and evaluate the long term performance of anaerobic digestion with thermal pretreatment.
BASES interactive learning platform (BASES=Biorecycling for Advancing Sustainability on Earth and in Space)

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Keywords: anaerobic digestion, microalgae, biofuel, education, outreach

As research is only as effective as the depth of its reach, our lab has developed a mobile outreach station to demonstrate the fundamental concepts of our research to the public at various community events. The mobile unit is called BASES – Biorecycling for Advancing Sustainability on Earth and in Space. Using the engineered processes of anaerobic digestion, microalgae production, and hydroponics, BASES is a live demonstration of the concept of biorecycling.

Biorecycling is the biological processes by which elements are continuously transformed from one state to another. As elements are recycled, sustainable solutions for securing food, water, and energy resources become apparent, as resource recovery is an integral component of biorecycling. Educating the public using the systems thinking approach of biorecycling fosters a new perspective on the life cycle of materials. Materials once regarded as waste (i.e., food scraps, human waste) are now potential sources of nutrients, water, and renewable energy.

The biorecycling educational material developed for this unit focuses on the carbon cycle and emphasizes the inherent biological processes responsible for recycling elemental carbon. Three biorecycling technologies and processes (anaerobic digestion, algae biofuel, and hydroponics) are used to demonstrate how engineered systems can utilize biological pathways to recycle waste to yield products that are useful to society. The following pathways are used to highlight biorecycling potential with linking multiple engineered processes: biogas from anaerobic digestion (carbon dioxide) is used to feed the algal photobioreactor; nutrients from anaerobic digestion is used to feed algae and hydroponics; water from the algae photobioreactor is circulated through hydroponics; water from hydroponics recirculates back to algae photobioreactor; dead algae and plant material is anaerobically digested to close the loop.

The objective is to expose students to engineering topics by building on science concepts, in order to demonstrate how the concepts are applied in their lives and to attract interest in the engineering field at an early age. Aside from the demonstration units of each engineered processes, an interactive educational module is available for visitors to explore.
ICARUS: A Passive Membrane Photobioreactor for Isolated Cultivation of Microalgae in Wastewater

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Keywords: microalgae, wastewater, phycoremediation, photobioreactor

Microalgae contribute significantly to the global economy, but bottlenecks in culturing and harvesting make large-scale production economically challenging. The isolated cultivation of algal resource utilizing selectivity (ICARUS) process, which integrates a passive membrane photobioreactor configuration with wastewater as a growth medium, is introduced. Eleven membranes of varying porosity and materials were examined in regard to algae productivity. Four ICARUS series (40kDa-PVDF, 0.53 g L\(^{-1}\), 14.1 mg; 0.1µm-PVDF, 0.43 g L\(^{-1}\), 16.6 mg; 12kDa-RC, 0.35 g L\(^{-1}\), 14.5 mg; 0.2 µm-CA, 0.41 g L\(^{-1}\), 16.6 mg) had a final cell density and mass yield that was significantly higher than that of algae suspended directly in wastewater (0.25 g L\(^{-1}\), 9.1 mg). Six series maintained significantly longer exponential growth phases than the suspended cultures. The ICARUS series maintained a significantly lower average pH (9.55) than the suspended culture (10.21).

Select membranes from laboratory experiments (12kDa-RC, 40kDa-PVDF, 7µm-NY) were tested in extended field conditions, where the movement of dissolved constituents and biomass productivity were compared to that of closed suspended series. All ICARUS series had higher biomass productivity (RC, 2.87 g L\(^{-1}\); PVDF, 10.6 g L\(^{-1}\); NY, 8.45 g L\(^{-1}\)) than the suspended series (0.38 g L\(^{-1}\)), which was due to a longer exponential growth phase and passive dewatering in the ICARUS series. Dissolved ions passed readily across each membrane. Gas exchange was slower than expected, which may have been due to attached growth utilizing gases at the membrane surface. Dissolved oxygen concentration did not limit algal growth, and adequate carbon dioxide was available to regulate ICARUS pH (maintaining an average pH of 7.6, compared to 9.8-10.5 in control series). The invasion of endemic wastewater species was dependent on pore size; the RC and PVDF series maintained a monoculture, but the NY series had severe contamination.

The resulting research has demonstrated a proof-of-concept of a new microalgal cultivation method which may reduce the cost of large-scale cultivation efforts integrated at wastewater treatment plants or within existing algal production facilities. Investigating various wastewater effluents, membranes, and algal strains has allowed for recommendations for the operation of scaled-up systems. By improving large scale algal cultivation, algal biofuels may become more economically competitive with fossil fuels or other renewables.
Hyporheic Zone Management: Nitrate Removal from Treated Wastewater Effluent using an Engineered Hyporheic Zone as a Bioreactor

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Keywords: Stream Hydrology, Hyporheic Zone, Hydraulic Conductivity Enhancements, qPCR

The hyporheic zone (HZ) is a natural bioreactor within streambed sediments. The dynamic interface of streamwater and groundwater creates a diverse microbial community that has potential to provide substantial contaminant removal. However, insufficient water exchange between the stream and the HZ is often a limiting factor for improved streamwater quality. Modular subsurface hydraulic conductivity (K) modifications with the addition of organic carbon substrates have been proposed as a means to increase hyporheic exchange and enhance natural water treatment via denitrification. Subsurface K modification flow paths are well understood from previous computer modeling and tracer testing studies, but treatment capabilities have yet to be tested in physical systems.

This research applied chemical and molecular biological techniques to investigate nitrate removal and microbial community structure in a bench-scale stream simulation with subsurface K and carbon modifications. The system received treated wastewater effluent containing soluble nitrogen primarily in the form of nitrate at concentrations fluctuating from 4-7mg/L. To gain insight into denitrification potential and relative microbial activity along hyporheic flow paths, profiles of nitrate fate, total bacterial presence and the density of the denitrification genes (nirS and nirK) were quantified spatially.

Nitrate tests showed a decrease from ~7mg/L in the influent to less than 1mg/L along hyporheic flowpaths. This was accompanied by an increase in 16S rRNA copies (representative of total bacterial biomass) from approximately 200000 gene copies in the influent zone to 630000 gene copies in the effluent zone. Also, the bacterial communities had a greater presence in the upper 6cm of the sediment layer with nirS amplifying 4-5 cycles earlier than nirK in the PCR analysis. The nirS gene concentration was nearly an order of magnitude greater in the effluent zone than the carbon modified zone, suggesting that leached dissolved organic carbon was fueling the process downstream. Our findings show the value of coupled chemical, hydrological and microbial analyses for the optimization of engineered denitrification zones in HZ systems and could further present monitoring tools for assessing environmental performance in situ.
Impact of Microgrids on Carbon Emissions Reduction on a Smart Grid under Carbon Emissions Control

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**Keywords:** Microgrids, Smartgrids, carbon emissions

The challenge of assuring operational reliability of Smartgrids will continue to rise with the increase in the percentage of total electricity demand supplied by microgrids with renewable generating portfolios. This paper aims to address this challenge by developing a model for obtaining optimal operational strategies for microgrids subject to optimal dispatch of electricity by the smartgrid. A bi-level mixed integer programming model is presented. The upper level model seeks to minimize the operational and emissions cost in the microgrids. The lower level model finds the optimal dispatch of electricity while accounting for interactions among the market participants: GENCOS, microgrids, and consumers. The lower level model is a typical DC optimal power flow (DC-OPF) formulation that is modified by incorporating the social cost of carbon, emissions cap, and considering microgrids as both consumers and suppliers. A designed experiment is performed using the results from the bi-level mixed integer programming model to obtain response surfaces that are later used to provide policy guidelines via a Pareto analysis. Using an 82 bus sample smartgrid network supporting 37 microgrid communities of sizes varying between 50 to 1000 households, we examine the impact of microgrid penetration, social cost of carbon, and the emissions cap on electricity prices, electricity consumption, total carbon emissions, and social welfare.
The Impact of Incentive Policies on a Renewable Energy Investment Decision

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Keywords: Smart Grid, Investment model, Incentive policies, electricity Regulation, Mixed Integer Programming, Distributed green generation and storage.

Higher level of green distributed energy generation and storage will lead to a significant reduction in carbon emission and also reduces cost of electricity in the grid, especially during peak times. Since the renewable green energy generation is still relatively expensive, there are federal, state and utility incentives to increase penetration of distributed green energy generation. In this study, we aim at developing a decision making model for the consumers to find the optimal level of investment in each technology for participation in smart grid. Then we will examine the impact of different incentive policies on the level of investment in green energy generation and storages for different regions in the country.

Based on existing incentives, consumer characteristics, price of technologies and the weather forecast, a Mixed Integer Programming (MIP) model has been developed and solved using Cplex in order to find optimal level of investment in renewable energy generators and storages corresponding to the minimum annual cost of energy. Four main categories of incentives are considered in this study: performance based incentive (PBIs), federal tax credit, rebates programs, and loan programs. PBI is production based compensation. Rebate programs, federal tax credit and loan programs are capacity based incentives.

Finally, we demonstrate a case study. An investment decision for a residential customer in Orlando-FL is shown. Based on this investment decision, a sensitivity analysis on several regulations and incentive policies has been done. Results coming out of this sensitivity analysis are surprising and very useful by the regulators. The green investment decision model can also be used for small businesses to decide the most profitable portfolio of renewable generators to invest in. This research aims at optimally exploiting the current incentives, and reducing share of current fossil fuels which produce huge volume of carbon dioxide emission. This can increase social welfare in the long term.
The Impact of Millennials’ Travel Behavior on Future Personal Vehicle Travel

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Keywords: Millennials, vehicle travel, travel behavior, travel demand

The millennial generation, born between 1980 and 2000, is exhibiting different travel behavior trends than previous generations, which are shaped by several different yet correlated characteristics such as; place of residence, race/ethnicity, labor force participation, education level, income, living arrangements, lifecycle status, licensure status, vehicle ownership/availability, values, and propensity to substitute technology for travel. Many millennials are living with their parents longer, obtaining drivers licenses at older ages, postponing marriage and procreation, and substituting travel for work and socializing with telecommuting and social media. Millennials are currently shaping the nation’s changing demographics, which in turn directly affect future travel behavior trends and their consequences on energy consumption and the environment.

The objectives of this research are fourfold. First, how does Millennial travel behavior differ from previous generations’ travel trends? Second, what factors such as socio-economic and demographic characteristics of this generation explain the different travel trends? Third, will these travel trends persist as the Millennial generation ages, or will this age cohort grow out of the current trends? Finally, will subsequent generations likely follow the Millennial travel trends, revert back to previous generations travel trends, or make their own new travel trends?
Decontamination of water from Organics using Graphene-Metal Oxides (TiO$_2$, ZnO) photocatalysts

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Keywords: nanomaterials, titanium oxide (TiO$_2$), zinc oxide (ZnO)

In recent years, the organic remediation of water has been studied extensively through photocatalytic technique using titanium oxide (TiO$_2$) and zinc oxide (ZnO) nanomaterials. The photocatalysts nanoparticles and nanowires were synthesized through common methods such as hydrothermal and sol-gel [1]. In fact, it is challenging to control the size and shape and quality of the nanowire, and find effective remediation of organics in the visible light. The success of organic remediation using iron and silver as dopant in ZnO has been shown from our group [2, 3]. Besides, the graphene doped photocatalyst ZnO nanowires and graphene doped TiO$_2$ nanoparticles have also been used to effectively remediate organics from water [4].

In the present work, G-TiO$_2$, G-ZnO, G-(ZnO+TiO$_2$) nanocomposites were synthesized by using hydrothermal techniques and sol-gel techniques. Each synthesized material was characterized using SEM, FTIR and X-Ray diffraction, techniques. The graphene doped TiO$_2$ nanoparticles shows the better remediation in visible light than graphene-ZnO based materials. The comparative remediation properties of organics (methyl orange (MO), toluene, naphthalene etc.) with and without presence of surfactant were studied under visible light. The presence of surfactant enhances the photocatalytic activities of the doped nanowires in visible light.

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Operational Impact of Alternative Taxiing on Block Time and Relevant Airline Cost

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Keywords: Alternative taxiing, Quantile regression model, Sensitivity analysis

Alternative taxiing is an innovative way of moving aircraft between airport gates and runways without turning the main engines on. Previous studies have mainly focused on the environmental impact analysis of alternative taxiing systems as they are powered by green energy (e.g., electricity). However, the operational characteristics of alternative taxiing on airport surface movement have also been noticed and its impact on relevant airline cost has not been deliberated.

This study investigates the effect of alternative taxiing on block time and airline indirect cost by applying quantile regression model coupled with sensitivity analysis. Using historical data, the correlations between taxi-time and block time are explored first. By recognizing possible changes of airport surface movement in the future caused by alternative taxiing, different scenarios are created for a sensitivity analysis. Then borrowing results from other related studies, the changes of scheduled block time and eventually the impact on airline costs (e.g., fleet utilization and labor costs) for different scenarios are evaluated. The proposed approach in this study offers an innovative integration of analysis methods to derive a framework that isolates taxi-time impacts on the block time and evaluating consequent airline cost. This study quantifies the impact of alternative taxiing on airline operational and financial performance and offers decision support to potential users and other stakeholders by understanding the values of the emerging technologies from airlines’ perspective.
An Integrated Transportation and Air Pollution Modeling Framework for Estimating Mobile Source Emissions and Human Exposures: Application to the Tampa Region

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Keywords: Traffic pollution, Transportation modeling, Air pollution modeling, Exposure analysis

The 2014 World Health Organization disease burden statistics attribute about 7 million worldwide premature deaths to air pollution, making it the largest single environmental health risk. Within the urban context, exposure to traffic-related pollution is a major concern. In this study, we present a framework that utilizes activity-based transportation demand modeling to estimate mobile source emissions and population activity; both are essential components of exposure estimation. Our geographic focus is Hillsborough County, Florida and the pollutant focus is NOX and PM2.5-black carbon. The framework utilizes an activity-based travel demand model (DaySim) to estimate daily activity-travel patterns for a synthetic population of residents in the study area, generated using Census data. The activity-travel patterns include, for each individual in the study area, high-resolution spatial location and time-of-day of individuals’ daily activities, along with activity durations at those locations and the modes used to travel between different locations. Subsequently, a dynamic traffic assignment model (MATSim) is used to estimate travel routes between the different activity locations.

These data are used to derive the spatiotemporal distributions of population activity in the study area. In addition to disaggregated travel route information, MATSim also provides roadway link-specific vehicle volumes and average speeds at an hourly temporal resolution. These data are input to a mobile source emissions model (MOVES) to generate link-specific estimates of diurnally varying emissions for the study area. Ultimately, emissions are input to a dispersion model (AERMOD) to obtain the spatiotemporal distribution of pollutant concentrations in the study area. These distributions are combined with the distributions of human activity to generate estimates of population exposures to pollutants. Such estimates of population exposure under alternative scenarios of urban land-use design and transport policies can be used for understanding interactions between urban design, air pollution, and health.
Direct numerical simulation of scalar transport across a wind-driven air-water interface

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Keywords: Langmuir turbulence, Langmuir circulation (LC), direct numerical simulation (DNS)

When wind blows over an initially quiescent air-sea interface, it first generates short capillary waves which in time coexist with longer waves as part of a broad spectrum of waves. The interaction between the wind-driven waves and shear current on the waterside leads to Langmuir turbulence characterized by Langmuir circulation (LC) consisting of counter rotating vortices roughly aligned in the direction of the wind. The typical length scale of LC ranges from several centimeters when short capillary waves first appear up to tens of meters when the spectrum of waves broadens.

Results are presented from direct numerical simulation (DNS) of a coupled air-water interface driven by an air flow with free stream speed of 5 m/s. The evolution of the air-water interface starting from rest and the accompanying development of centimeter-scale Langmuir turbulence on the waterside are investigated. Emphasis is placed on the impact of the Langmuir turbulence on scalar transfer from the airside to the waterside, in particular the transfer velocity which is a measure of scalar transfer efficiency. Simulations are made with a finite volume discretization employing the volume of fluid method for interface tracking. The simulations resolve both air and water sides of the interface.
Bioenergy Production from Municipal Solid Waste by Solid-State Anaerobic Digestion

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Keywords: solid-state anaerobic digestion, bioenergy, biogas, resource recovery, sustainability, renewable energy, waste management

Solid-state anaerobic digestion (SS-AD) is a bioenergy production technology characterized by a high solids content (15-30% solids). It is widely used in Europe to produce biogas from the food and yard waste; however, to our knowledge only one commercial scale SS-AD facility is currently operating in the US. Advantages of SS-AD include faster waste degradation and higher biogas quality than conventional or bioreactor landfills, lower water use and leachate production than wet anaerobic digestion technologies and production of a nutrient rich fertilizer. The overall goals of this project are to evaluate the potential for SS-AD in Florida and to improve the rate of biogas production during co-digestion of the organic fraction of municipal solid waste (OFMSW). Specific objectives are to: 1) evaluate the most appropriate technologies for implementing SS-AD of OFMSW in Florida, 2) carry out fundamental research at bench- and pilot-scale to improve the biodegradability of lignocellulosic waste through co-digestion with pulp and paper waste sludge, 3) identify potential sites, collaborators and funding sources for a large scale SS-AD demonstration project in Florida. Results from this project will be disseminated widely to a variety of stakeholders including FDEP, USEPA and county regulators, county solid waste directors and their staff, private waste management companies and other associated industries, university and K-12 students, engineers, operators, scientists and community members.
Florida native plants for Rain Gardens- A comparison of effective phosphorus removal from stormwater runoff

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Keywords: Rain garden, phosphorous, Stormwater

Phosphorous is a pollutant found in stormwater runoff that can lead to eutrophication of water bodies. Increased urbanization and population growth in Florida has contributed to a steady increase of stormwater containing phosphorous and nitrogen, with phosphorous being the limiting nutrient in freshwater surface bodies. Rain gardens are a type of green infrastructure that retain stormwater runoff from roofs, impervious surfaces, and vegetated areas so that plants and media can utilize and remove runoff constituents like phosphorous and enable percolation through the soil. Read et al. (2009) suggest that particular plant species combined with a good planting media mixture accelerate the removal of pollutants from stormwater runoff. The rain garden, usually ranging from depths of 0.5 to 2.0 feet, serves as a retention area for stormwater. Twelve Florida native plant species were introduced into and later harvested from three different rain gardens in Tampa packed with gravel, sand, top soil, and mulch media layers. The plants were analyzed for phosphorus content using the wet phosphorous technique. These data will be used to estimate the role of plants in phosphorous removal from a rain garden and compare the effectiveness of the various species to remove phosphorous.
Decision Support Modeling Toward Net-zero Water Consumption in Smart Buildings

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Keywords: Alternative water supplies, fit-for-purpose, integrated building water management, net-positive, prioritization, water reuse and recycling

Net-zero buildings emphasize balance between the consumption and production of resources, resulting in structures that are not only more efficient, but potentially restorative. While historically applied to energy use, the net-zero framework is also relevant to water management. Both the building energy and water sectors consist of demand loads that must be met by available sources. Variations in load design, source allocation, and human interaction result in numerous arrangements that require evaluation to meet efficiency goals. Decision support systems aimed at building energy are abundant, whereas building water tools are limited. However, the dynamic nature of the building water cycle necessitates flexible modeling tools that can predict and assess water consumption and production trends at varying resolutions and under fluctuating conditions.

Smart buildings utilize technology to increase the efficiency of building operations through systems integration. Smart building operations initially focused on the efficiency of heating, ventilation, and air conditioning (HVAC) components; however, smart buildings have grown to incorporate all subsystems housed within the building envelope. With regards to the water subsystem, practices that aim to reach the net-zero goal, such as the use of alternative water sources and the reuse of wastewaters, significantly complicates the building water cycle. An integrated building water management (IBWM) approach that takes into consideration water from various sources, both inside and outside the building, should be implemented in order to enhance the intelligence of buildings, and smart buildings may be better equipped to maximize the efficiency of the building water cycle. This poster presents opportunities for simulation modeling to support net-zero water achievement and introduces an integrated building water management (IBWM) model for on-site water balance decision support based on a presented framework for net-zero and net-positive water achievement. The feasibility of achieving water neutrality using the framework is evaluated by applying the IBWM model to a hotel building site in west central Florida.
Use of Truck Probe Data for Analyzing Truck Flows at Statewide, Mega-region, and Local Levels

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Keywords: origin-destination (OD) demand data, truck-GPS data

Accelerated growth in the volume of freight shipped on American highways has led to a significant increase in truck traffic, influencing traffic operations, safety, and the condition of highway infrastructure. Traffic congestion in turn has impeded the speed and reliability of freight movements. Appropriate planning and decision making processes are necessary to mitigate these impacts. However, a main challenge in establishing these processes is the lack of adequate data on freight movements such as detailed origin-destination (OD) demand data. This research aims at investigating the use of large streams of truck-GPS data for understanding truck OD flows in the nation at different geographic scales – statewide, mega-regional, and local levels. Specifically, a recently emerging source of GPS data on truck movements from the American Transportation Research Institute (ATRI) has provided an unprecedented opportunity to study freight truck movements throughout the nation.

This poster will exhibit a case study of the use of this data for analyzing truck flows in the nation at different geographical scales. In doing so, the study will test the hypothesis that a majority of the freight flows in the nation operate at a mega-regional scale of geography. Specifically, as the concept of mega-regions is increasingly gaining importance in the context of freight planning, this research will shed light on truck flows into (and out of) the Florida mega-region from (and to) other mega-regions in the nation. As importantly, the research evaluates the use of this data for understanding urban goods movement at a more local level; for example, for the Tampa Bay region.
Improved Traffic Control Measures to Prevent Incorrect Turns at Highway-Rail Grade Crossings

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Keywords: highway-rail grade crossing, GPS, downstream countermeasures

A number of injuries and fatal collisions have occurred at certain highway-rail grade crossings that are located immediately adjacent to highway intersections, driveways, interstate ramps. To evaluate benefits of safety improvements at rail-grade crossings, study focuses on implementation of countermeasures at selected sites in Florida. Each site is considered on high risk of crashes and fatalities, there are currently four sites being evaluated. Quantitative data is collected on the basis of confusing signs and pavement markings near highway-rail crossings, darkness and low visibility near or at highway-rail crossings, following inaccurate turn instructions from a GPS device onto railroad tracks, skewed highway-rail grade crossings, and driver distraction. Data is collected before the study and after the study to evaluate the effectiveness of the countermeasures which are implemented in each site. Specific Countermeasures are implemented by CUTR for upstream of a highway-rail grade crossing include advanced direction signage, striping, and elimination of confusing pavement markings and signs. For downstream countermeasures also consist of guide signs and striping. For critical zones, countermeasures such as striping, dynamic envelope pavement markings, installation of delineator posts, pavement gate markings, bollards, and illumination are recommended. To alleviate the problem of darkness and low visibility, adequate illumination is essential for reducing the number of rail-vehicle crashes and stuck vehicle incidents due to incorrect turns at night. This study focuses on phase 1 of the pilot study to reduce accidents and evaluate effective countermeasures with to prevent incorrect turns at highway rail grade crossings.
Environmental Impact Analysis of Electrospun PCU Nano fibers

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Keywords: Nanotechnology, Life cycle assessment (LCA), Polyurethane carbonate (PCU), Nanofibers, Electrospinning, Sustainability

It is very important to evaluate the environmental impacts of synthesis, process, or products associated with an emerging technology like nanotechnology. Life cycle assessment (LCA) is one of the recognized reliable techniques used to assess sustainability impacts. This study includes the comparative LCA of the production of Polyurethane carbonate (PCU) nano fibers using N,N-Dimethylformamide (DMF) and Tetrahydrofuran (THF) solvent mixtures (1:0, 0:1, 1:1, 3:7, 7:3). The aim of this study is to analyze the impact of solvents for the fabrication of PCU nanofibers and plan for the use of more environmentally friendly solvent to produce sustainable nanofibers. The stages considered for LCA analysis are materials, processes used for preparation of polymer solution, and power consumption used in electrospinning the nanofibers. The comparisons are made on equal mass basis i.e. materials, processes used to fabricate 1 gram of PCU nano fibers (functional unit). The entire inventory is compiled from open literature. LCA software version Simapro 7 is used. IMPACT 2002+ Life Cycle Impact Assessment (LCIA) tool is used to evaluate the environmental impacts. The preliminary results of this study reveals PCU nanofibers fabricated through DMF alone has less environmental impact in terms of all impact indices when compared to rest.
A Novel Fungal Bioleaching Process for Recovery of Lithium and Cobalt from Spent Lithium-Ion Batteries

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Keywords: Lithium, cobalt, metal recovery, spent lithium-ion batteries, fungal bioleaching, extraction kinetics

The growing application of rechargeable lithium-ion batteries is increasing the demand for lithium and cobalt, and disposal of these batteries at the end of their lifetime is also posing a big environmental concern. In this poster a novel biological process for separation and recovery of valuable metals such as Li and Co from spent lithium-ion batteries is proposed. Conventional processes used for recovery of valuable metals from solid wastes are pyrometallurgical and hydrometallurgical methods. Recycling by pyrometallurgical processes contaminates the environment due to the emission of toxic gases, and hydrometallurgical processes require rather extreme conditions of temperature, pressure, and chemical environment. Bioleaching processes have been gradually replacing hydrometallurgical and pyrometallurgical processes due to their higher efficiency, lower costs, fewer industrial requirements, and lower environmental impact. Compared to bacterial bioleaching, fungal bioleaching has the advantages of tolerance to low pH, resistance to release of more toxic metals, and better extraction kinetics. Fungal bioleaching has been applied for the extraction of metals from industrial solid wastes in many cases but it is yet to be applied for recovery of lithium and cobalt from spent Li-ion batteries.

In this project, the bioleaching process will be carried out using three different adapted fungi (Aspergillus niger, Penicillium simplicissimum and Penicillium chrysogenum) to produce organic acids which include citric, oxalic, malic and gluconic acids during bioleaching. The objective will be the recovery of at least 80% of lithium and cobalt in organic acids excreted by fungi under realistic operating conditions. The dependence of key bioleaching performance aspects (production of organic acids, growth of fungal biomass, extent of extraction of target metals, and kinetics of extraction) upon operating conditions (pulp density, pulp composition, temperature, pH, carbon source, and reducing agent) will be investigated. It is anticipated that a 3% pulp density will produce the highest concentration of various organic acids, and as a result, the highest lithium and cobalt recovery will be achieved. The metal concentration at various stages of the process will be determined by Atomic Absorption Spectrophotometry (AAS) and organic acids will be analyzed by High Performance Liquid Chromatography (HPLC). It has been estimated that this process would lead to savings of approximately 20-40% overall costs at industrial scale due to lower capital and energy cost. The process will also help to curb the exportation of electronic waste from North America to China, Ghana, and other developing countries for disposal.
α-Fe$_2$O$_3$ and Blend Regioregular Polyhexylthiophene Films for Water Splitting Application

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**Keywords:** Water Splitting, Photoelectrochemical, hematite (α-Fe$_2$O$_3$), and nanomaterial-polyhexylthiophene

Our recent research has been focused on photoelectrochemical technology for water splitting to hydrogen and oxygen using visible light. The iron oxide i.e., hematite (α-Fe$_2$O$_3$) and blend of α-Fe$_2$O$_3$ with regioregular polyhexylthiophene were used as nanostructured electrode materials. The hematite and zinc doped hematite nanomaterials were synthesized and characterized using SEM, FTIR, and UV-visible spectroscopy techniques, respectively.

The photoelectrochemical properties of the hematite and doped hematite were studied in 1.0 M NaOH electrolyte. The photocurrent of 15 -20 mA/cm$^2$ at 1.8 to 2 V for thin film Fe$_2$O$_3$ nanoparticles in NaOH as electrolyte has been also investigated. The photoelectrochemical properties of hematite film on FTO coated glass plate and blend of nanomaterial containing regioregular polyhexylthiophene films as anode and cathode electrode materials under the visible light were experimentally investigated. The influence of thin film α-Fe$_2$O$_3$ combined with conducting polymer enhanced the splitting of water molecules amounting to the production of hydrogen and oxygen. The enhanced hydrogen and oxygen has also been observed for nanostructured polyhexylthiophene blend with hematite films. The optimized nanomaterial-polyhexylthiophene and doped hematite films could be the better structures for water splitting applications.
Development of a kinetic model for microalgae growth in wastewater

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Keywords: Microalgae growth, kinetic model, light intensity, temperature

Microalgae are a potential energy resource for biofuel production due to many benefits including high productivity, high CO$_2$ fixation rate, high oil yield, and low land use. The high nutrient and energy requirements for microalgae cultivation, however, could lead to high operation costs and environmental impacts. Integration of microalgae cultivation system with wastewater as substrate has been suggested for sustainable biofuel production. To realize such integration, the growth kinetic of microalgae in wastewater is needed. Therefore, the goal of this study is to develop a new kinetic model of microalgae growth using wastewater as substrate. The framework of the model is a combination of threshold and multiplicative structures. Nitrogen, dissolved CO$_2$ concentrations, light intensity, and temperature were selected as major growth factors in the model. To achieve the study goal, one objective is to determine a rate expression for light intensity coupled with temperature.

In this study, *Chlorella sp.*, collected from Howard F. Curren Advanced Wastewater Treatment Plant (HFC AWTP) in Tampa, Florida, was cultivated in 1L batch photobioreactors. Centrate from dewatering of anaerobically digested sludge obtained from Northeast Water Reclamation Facility (located in Clearwater, FL) was used as a nutrient resource. The experiment was conducted at a controlled temperature room (22±1°C). During the experiment, 5% CO$_2$-air mixture was injected through a fine bubble diffuser into the reactors at the flow rate of 400ml/min. The reactors were illuminated by 13W fluorescent lamps installed outside of the reactor to provide the desired light intensity.

Concentrations of microalgal biomass were measured under different light intensity (0-459μmol/m$^2$s) in the centrate. Kinetic parameters (Maximum specific growth ($\mu_{max}$), Light intensity at saturation point ($I_s$), Light intensity at the energy compensation point ($I_e$)) of Steele and Muller-Fuega models were determined by fitting the predicted specific growth rates ($\mu$) to the calculated rates based on the experimental growth curves. The results showed that both Steele and Muller–Fuega models gave a good fit with the light intensity below 218 μmol/m$^2$s. Above 218 μmol/m$^2$s, it was observed that the $\mu$ increased due to a temperature rise associated with enhanced light intensity. To account for light intensity and its temperature effect on the growth, the Steele and Muller-Fuega models combined with several existing temperature expressions were tested. The results showed that Muller-Fuega model combined with Arrhenius equation gave the best fit, and the estimated growth parameters were $\mu_{max} = 0.56d^{-1}$, $I_s=39.9\mu$mol/m$^2$s, $I_e=5.3\mu$mol/m$^2$s, and $\Theta=1.172$. 
Study of a Bioretention System with an Internal Water Storage Zone for Nitrogen Removal Under Field Conditions

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Keywords: Bioretention, denitrification, nitrogen removal, stormwater, urban runoff, low impact development technologies, rain gardens

Urban stormwater and nutrient management is increasingly becoming important as urbanization in coastal cities continues to increase. Florida led all states with a 75% coastal population growth between 1980 and 2003. As urban development increases, more land is paved, reducing impervious surfaces, infiltration rates, and groundwater recharge; thereby, altering natural runoff pathways and increasing urban runoff. In the Tampa region, high levels of Nitrogen (N) and Phosphorus (P) found in the runoff overload Tampa Bay and its adjacent environments, degrading the quality of the water. Some of the consequences are excessive algal growth and eutrophication, which in turn causes a reduction to light penetration, sea grass mortality and decreased levels of dissolved oxygen.

A study by the EPA and Florida DEP found that the largest contributor to N in the Tampa Bay watershed after regulating point sources such as wastewater treatment plants was from non-point sources, specifically residential use. Part of a Best Management Practice (BMP) that can be applied to reduce N loads from urban runoff to Tampa Bay are the use of structural Low Impact Development (LID) technologies such as bioretention systems (a.k.a “rain gardens”). Bioretention systems are a shallow depression with a planting bed and a series of permeable layers where the water is filtered. Prior studies have shown how the use of an internal water storage zone (IWSZ) containing an electron donor that supports denitrification has resulted in total N removal efficiencies greater than 88% under laboratory conditions. This research looks further at how bioretention systems with an IWSZ perform in reducing nitrogen loads from urban runoff to Tampa Bay and can be implemented in residential areas using locally available materials.

The University of South Florida and the Corporation to Develop Communities of Tampa, Inc. (CDC) are collaborating to install bioretention systems on CDC properties to increase community awareness of the benefits of bioretention, evaluate N removal under field conditions and promote bioretention systems among the residents of the Tampa Bay watershed.
Investigation of EDTA Modified Silica for Removal of Metal Ions

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Keywords: EDTA/SiO₂, Wastewater Remediation, Synthesis, Heavy Metals, Chelation

The motivation for this project is to find an improved method to treat contaminated wastewater, particularly for the removal of detrimental metal ion contamination. While the supply for fresh water is decreasing, the worldwide demand for fresh water grows and must be met. Metal ion contamination has been shown to potentially have a prolonged effect on human life at low concentrations. Previous studies have shown promising results for ethylenediaminetetraacetic acid (EDTA) functionalized silica as a highly efficient method for the removal of Cu(II), Zn(II) and Ni(II) from an aqueous solution. In this study, the investigation of different parameters of the synthesis, such as the optimal ratio of silica to EDTA, is being quantified and studied to find the most effective synthesis conditions.
Hydrothermal Synthesis of MoO$_2$ Nanoparticles Directly onto a Copper Substrate for the Anode of a Lithium-Ion Battery

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Keywords: Synthesis, Molybdenum Dioxide, Copper, Nanoparticles, Battery

A simple one-pot hydrothermal technique has been developed to synthesize MoO$_2$ nanoparticles directly onto a Cu substrate. This is a first time MoO$_2$ has been synthesized directly onto a Cu substrate, and could lead to other materials being synthesized directly on Cu in a similar manner. Not only did this technique reduce anode production time by eliminating the coating process, but also reduced the amount of chemicals used when compared to a typical powder synthesis and coating process. The anode was characterized using XRD and SEM to determine composition, crystallinity and structure. Cyclic voltammetry, chronoamperometry and electrochemical impedance spectroscopy were conducted to measure the electrochemical properties.
Can We Re-use “Single-Use” Solid Phase Extraction Cartridges?

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Keywords: Solid Phase Extraction cartridge, SPE, reuse, water, water quality, endocrine-disrupting compounds, EDC, 17β-estradiol, E2, bisphenol-A, BPA

Organic and inorganic compounds are present as contaminants in varying concentrations throughout our water cycle. Examples of these contaminants include the endocrine disrupting compounds (EDC’s) bisphenol-A (BPA) and 17β-estradiol (E2) from plastics and pharmaceutical use. It can be necessary to obtain the concentration of these compounds within the water cycle for analysis by interested parties such as research groups, regulatory agencies, and private organizations. These concentrations, however, can be too dilute within the initial sample for analysis. Therefore it is necessary to concentrate the compound of interest (analyte) prior to analysis. One such way to do this is by way of Solid Phase Extraction (SPE).

SPE uses a small cartridge which contains chromatographic packing material to chemically extract analytes from a water sample. To increase concentration, these analytes are then transferred to a substantially smaller volume of organic solvent for eventual analyses. These commercially available cartridges are relatively inexpensive, approximately $5 each. However, these cartridges are labeled as single use. In large-scale analyses, this can quickly add up to a sizable percentage of the analysis budget. Additionally, sizable waste volumes can be generated from these analyses in the form of non-degradable polypropylene plastic. If these cartridges can be re-used, material costs as well as waste volumes can be substantially reduced. However, little is known regarding how the quality of analysis degrades with cartridge re-use. The objective of this project is to evaluate the number of times SPE cartridges can be reused without compromising the results of the subsequent analyses.

Based on a review of prior literature, we have identified and developed protocols for extracting analytes (BPA and E2) from water, then analyzing them with gas chromatography and mass spectrometry (GC-MS). These protocols have been developed to mimic those employed by research labs, industry, and other entities for which the results of this study would be most applicable. The only deviation will be the re-use of the cartridge rather than disposal and replacement. Two types of commercially available SPE cartridges will be used. Multiple SPE runs will be performed on each cartridge and a history of the GC-MS peak areas, which indicate apparent analyte concentration, will be tracked. As the cartridge begins to degrade, it is expected these peak areas will exhibit statistically significant changes from one analysis to the next. This statistically significant change will indicate that the cartridge has exceeded the maximum allowable number of re-uses and will thereby identify the number of times the “single-use” cartridge can reliably be re-used.
Land Suitability Modeling of Shea (Vitellaria paradoxa) Distribution across Sub-Saharan Africa

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Keywords: African Land Suitability, GIS, Chocolate, Cosmetics, Food Security, Climate

Shea trees (Vitellaria paradoxa, synonym: Butyrospermum paradoxum or parkii) have been botanically recorded in 21 countries across semi-arid sub-Saharan Africa. Dried kernels are the source of shea butter, a stearic/oleic rich edible oil or fat consumed locally, and internationally as an ingredient in the multi-billion dollar cosmetic and confectionary sectors. For millennia shea has been a staple edible oil crop, significantly contributing to nutritional health, livelihoods and the community well-being of women collectors and their families. This research is the first known attempt to predict potential shea distribution and production using Geographic Information Systems (GIS) by combining binary and suitability layers developed from eight parameters: land-use, temperature, precipitation, elevation, fire, Normalized Difference Vegetation Index (NDVI), soil-type and soil-drainage.

The model is verified and validated using 302 GPS coordinates of shea trees and distributions developed by USAID West Africa Trade Hub (WATH). The model gives an extensive shea tree suitability area of 3.4 million km² across 23 countries with rural population of 112 million, including 18 million women collectors. Using conservative estimates, 1.8 billion trees (1.1 billion in high stearin areas) are predicted. Given current population densities, a collected crop of 2.4 million tons of kernels yielding greater than 800 thousand tons of shea butter is estimated (1.6 million tons high stearin kernel). As scientific knowledge on shea expands, the model’s suitability criteria can be fine-tuned and climate change, development and urbanization impacts estimated. The suitability model developed is thus useful to governments, non-government organizations, researchers, and industry in planning projects and investments in rural development, climate change, food security and biodiversity through shea production.
Nutrient Recovery from Centrate of Anaerobic Digestion

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Keywords: Wastewater, Nutrient Recovery, Centrate, Anaerobic Digestion, Nitrogen, Phosphorus, Struvite

The anaerobic digestion (AD) process in wastewater treatment plants (WWTP) produces effluent of both biosolids and liquid centrate. The liquid centrate contains significantly higher concentrations of Nitrogen (N) and Phosphorus (P) than the original wastewater. If N and P can be efficiently recovered from the centrate, it would provide the benefits of (1) reducing the nutrients in the discharge from the plant, thereby reducing eutrophication, (2) preventing the requirement of re-treating the centrate in a “second pass” through the plant, and (3) generating a commercial product.

The objective of this project is to identify, test, and demonstrate an innovative nutrient recovery method for anaerobic digester centrate. In this poster we review the current state-of-the-art for side-stream nutrient management at WWTPs. The most common method to recover N and P is through the precipitation of struvite, also called Magnesium Ammonium Phosphate. Many companies have recovered struvite through precipitation in WWTP to sell as a fertilizer. The struvite precipitation process is able to recover up to 95% of P but only up to 40% of N. The Water Environment Research Foundation (WERF), a leading independent wastewater research organization, describes the ability to recover N as a key information gap.

After identification of current state-of-the-art technologies, key challenges and knowledge gaps relating to nutrient recovery from centrate of AD and completion of the literature review, the author’s next steps include laboratory testing and demonstration at a local WWTP.
Effect of temperature shocks on an anaerobic membrane bioreactor (AnMBR) treating simulated domestic wastewater

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Keywords: anaerobic membrane bioreactor, domestic wastewater, temperature shock, fugitive methane, psychrophilic

Domestic and municipal wastewater contains more chemical energy than is needed for its treatment at municipal wastewater treatment plant. This energy can be recovered through anaerobic conversion of the organic material in wastewater into methane gas. There are many full scale applications of anaerobic treatment of domestic wastewater in tropical areas. Combined with anaerobic membrane bioreactors (AnMBRs) gaining recognition as a viable technology for treating low strength wastewaters, and the increasing interest in decentralized domestic wastewater treatment, especially short term temperature fluctuations (i.e. shocks) during anaerobic wastewater treatment should be studied in order to account for diurnal changes in temperature and demonstrate the robustness of AnMBRs, methane loss in the permeate, and COD accumulation. This is a long-term study of a 10 L laboratory scale AnMBR treating low-strength synthetic municipal wastewater under mesophilic to psychrophilic conditions with a transition period incorporating several temperature shocks. Average COD removal under mesophilic conditions was 94 ± 2% even when temperature shocks (15 °C) were applied. Average specific methane production was 0.27 L CH4/g CODremoved. More than 46% of overall methane produced was lost in the effluent while temperature shocks were applied. More than 70% of incoming COD accumulated in the system during the psychrophilic conditions due to the poor hydrolysis of solid particles. This study demonstrated that abrupt temperature decreases from mesophilic to 15 °C can largely be absorbed by the system without any interruptions in terms of COD removal efficiency, but psychrophilic operation is problematic due to fugitive methane in the effluent and accumulation of organic matter within the reactor due to lower hydrolysis rates.
The Effects of Climate Change on Water Supply in the Tampa Bay Region

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Keywords: Climate Change, Precipitation, Tampa Bay region

Climate change is a major concern. Even with just a slight temperature increase, ice caps have already started to melt causing a rise in sea level. As temperatures continue to increase, the threats will also increase. Exactly how precipitation patterns will change or the degree to which sea level will rise is uncertain, but planning now to ensure the availability of future water supply is critical. This research will focus on evaluating current and future water supply for the Tampa Bay, Florida region. It will primarily focus on the following these tasks:

- **Task 1**: To develop a decision making framework that accounts for climate change effects and sea-level rise impacts that will be incorporated in future water supply planning.

- **Task 2**: To investigate climate change impact on agency’s water supply operation.
Mathematical Modeling and Simulation of Adsorption and Mixotrophic Denitrification in a Tire-Sulfur Hybrid Adsorption Denitrification (T-SHAD) bioreactor

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Keywords: sulfur oxidizing denitrification; packed bed reactor; on-site wastewater treatment; mathematical model

A mathematical model of hybrid adsorption and sulfur oxidizing denitrification was developed to predict nitrate removal and sulfate production in a packed bed reactor under transient loading conditions. The utility of the model is that it facilitates the optimal design of bioreactors in onsite wastewater treatment (OWT) applications. The model predictions were compared to effluent NO₃⁻ and SO₄²⁻ concentrations from a bioreactor utilizing a tire-sulphur hybrid adsorption denitrification (T-SHAD) process. The model accounts for advective transport, axial dispersion and mixotrophic denitrification in the aqueous phase, and mass transport by surface diffusion between the solid and liquid phases.

One of the salient features of the model is that it accounts for mixotrophic denitrification, which is consistent with experimental results, which suggest that bioavailable organic carbon is leached from the adsorbent. The quantitative description of the T-SHAD process predicts the temporal evolution of the substrate and SO₄²⁻ effluent concentrations. The model takes the form of two partial differential equations (PDEs) which were solved using a finite difference approach. The simulation results showed that the model is capable of reproducing the experimental results.
Developing a Stormwater Mobile Phone App to Identify and Monitor Flooding Hotspots and Green Infrastructure

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Keywords: Green Infrastructure (GI), stormwater management, volunteered geographic information (VGI), public participation geographic information systems (PPGIS)

Stormwater runoff is a primary contributor of pollutant loading to valuable estuarine and coastal waters like the Tampa Bay Estuary. Excess runoff caused by increasing urbanization of watersheds can degrade water quality and cause problems such as hypoxia, algal blooms, fish kills and a loss of biodiversity. Green Infrastructure (GI) is a stormwater management strategy which focuses on restoring natural hydrologic regimes by taking a watershed scale approach to capturing, treating and infiltrating runoff. GI practices, like rain gardens, green roofs and permeable pavers, are often dispersed throughout a watershed to capture runoff as it is generated versus capturing runoff at the end of a catchment site. The dispersion of practices presents some issues with implementing the GI strategy. Most notably are the needs to develop on sites with varying land ownership, the question of how potential GI sites will be identified and the question of who will monitor and maintain established GI practices. We are currently developing an Android mobile phone app which will address those issues.

Our Hydro Hero stormwater mobile management app will be a citizen science tool to identify potential GI sites and monitor existing GI sites. By crowd sourcing spatial and qualitative data from community members we expect to promote a more community driven approach to stormwater management. Also, we expect a more engaged community would be more likely to choose to implement GI practices on their residential and commercial lands and to participate in maintaining those practices. This crowd sourcing approach is based off of research in related fields on the volunteered geographic information (VGI) and public participation geographic information systems (PPGIS) approaches. Previous VGI and PPGIS projects related to GI, have solely focused on identifying GI practices and their locations. Our research will expand on this by providing citizens a greater degree of involvement. The Hydro Hero app will allow citizens to not only identify, but also propose potential sites and monitor existing practices over time. We will be researching how best to engage the community and promote continuing usage of the Hydro Hero app. Also, the app is being developed to fit in both a community and K-12 educational setting.
Enhanced photoactivity of TiO$_2$/YAG:Er$^{3+}$ composite by addition of sensitizing Yb$^{3+}$

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Keywords: Wastewater remediation, photocatalysis, upconversion, titania, rare earth ions

Waste water remediation is a key component to a sustainable water management program and the use of photo-activated catalysts has emerged as a promising route to make the process less energy intensive. Through the heterogeneous photocatalytic oxidation process, titania and UV light generate hydroxyl radicals which convert toxic organics to relatively innocuous products. This procedure can also be performed under visible/IR irradiation by combining upconverting luminescent YAG:Er$^{3+}$ nanopowder, which can absorb visible and IR photons and emit UV photons through a multi photon process, with titania. As a means to improve upon this enhancement under ‘solar’ irradiation, YAG:Yb$^{3+},$Er$^{3+}$ was synthesized and combined with Degussa P25 TiO$_2$ to improve the catalyst’s photoactivity across the visible and IR spectra. The addition of the Yb$^{3+}$ ions allows for the excitation of Er$^{3+}$ ions, which are responsible for UV light emission, to occur not only through photon absorption but from the nonradiative transfer of energy that occurs from the decay of excited Yb$^{3+}$ ions. Four samples of the upconverting phosphor were prepared utilizing the Pechini method with varying molar concentration of Yb$^{3+}$ ions [0%,10%,15%,20%] and a constant concentration of Er$^{3+}$ ions [2%]. The composite materials were then obtained via calcination of the various YAG:Yb$^{3+},$Er$^{3+}$ samples with titania. The molar concentration of YAG:Yb$^{3+},$Er$^{3+}$ was varied from [10%,15%,20%] within the composites. Qualitative analysis of the upconverting phosphors and composite materials includes X-ray diffraction, diffuse reflectance spectroscopy, transmission electron microscopy and photoluminescence spectroscopy. The photocatalytic degradation of rose bengal dye was studied in a batch slurry reaction utilizing two sets of 5, 8W fluorescent bulbs, with one set emitting a spectrum comparable to the ‘daylight’ spectrum and the other emitting only UV light. Photocatalytic testing was also performed in a batch system using IR LEDs with the composites immobilized on a glass slide. UV-Vis spectroscopy was used to determine the degradation rate by observing the main absorption peak (549 nm) of the dye as a function of time. These three sets of experiments were performed to gain insight into the dual role, upconversion and electron trapping, the lanthanides play in enhancing the quantum efficiency of the photo catalyst.

References/Footnotes
NSF-US-UK research experience at University of Exeter: Influence of membrane filtration on wastewater as a feedstock for cultivating microalgae for biofuel

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Keywords: algae, wastewater, biofuel, Chlorella sorokiniana, membrane, UF, MF

The imminent threat of the consequences of global climate change and limited fossil fuels has led many to investigate alternative, low-carbon emitting fuel sources. Algal biofuels are of particular interest due to their carbon sequestering abilities. Incorporating the cultivation of algae at the wastewater treatment plant setting makes sense both theoretically and economically; algae take from the endless supply of nutrients in wastewater for growth, lowering the nutrient burden on the plant. The subsequent algal biomass can then be harvested and processed for biofuels and other bioproducts. This is the basic framework of the NSF Isolated Cultivation of Algae Resource Utilizing Selectivity (ICARUS) Project at USF. Through this project, we have investigated the use of wastewater in the City of Tampa for cultivating microalgae (see related poster). Through a special US-UK Clean Water Initiative, funding was obtained to send four USF students (2 PhD, 2 BS) to the University of Exeter for a 12-week research exchange during summer 2014. More on their experience can be found at: http://usfexeter.blogspot.com.

At the University of Exeter, under the direction of Dr. John Love’s Plant Biotechnology lab, research was preformed to observe synergistic/predatory relationships between Chlorella sorokiniana and the autochthonous microbial community commonly found in the clarified effluent from a municipal wastewater treatment plant (WWTP) at Exeter. A secondary objective of this study was to assess how Chlorella sorokiniana would perform within the aforementioned WWTP stream when they were filtered through microfiltration (MF - 0.1 µm nominal pore size) and ultrafiltration (UF - 40 kDa molecular weight cut off) membranes. These filtered streams would reveal whether similarly sized membranes would be adequate at filtering out potential predators to the algae. The growth experiments were therefore conducted using 3 different feed types per WWTP stream – Raw, MF filtrate, and UF filtrate. To assess the effect of bacterial presence, nutrient removal capabilities were compared between axenic algal cultures and algal cultures dosed with filtered and non-filtered aliquots of the clarified effluent stream. Concurrently, characterization of the evolution of the microbial communities grown within the clarified effluent was performed regularly by taking genomic DNA samples and processing them via Illumina Sequencing. At the end of this research, valuable sequencing skills and data were acquired as well as insight into the advantages (or disadvantages) of growing algae in these two WWTP streams.
Capacity Expansion of Distributed Generators using Bilevel Mixed Integer programming

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Keywords: Distribution generator, large scale optimization, Line - Switching

In recent years, the electric power industry has shown great interest for distributed generation (DG). These small scale generators include but are not limited to wind turbine, gas turbine, fuel cells, and biofuels. Having distributed generation placed strategically in the distribution network provides power loss reduction, improvement of voltage profile, reduction of network congestion and deferral of investment in network expansion. In addition, strategically placing DG units allow them to sell their power at an optimal profit to distribution companies (DisCo). In order to supply the demand of the network, distribution companies (DisCo) purchases power from DG units and wholesale electricity market price. However, the distribution companies can’t simply purchase the cheapest power due to the constraints of the electrical system. Therefore, the challenge is how to effectively allocate additional distributed generators (DG) within the constraints of the electricity market network to maximize DGs profits while minimizing Distribution Companies cost. To address this issue, we model the problem using bilevel mixed integer programming to capture the interaction between DG owners and DisCo. Due to the non-convexity of the problem, we reformulated and applied decomposition techniques to converge to an optimal solution, which provides strategic insights to allocating the distribution generators effectively.
Modeling Landslide Inducing Groundwater Table Surges in Residual Soils due to Rainfall

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Keywords: Groundwater Table, Soil Stresses, Empirical Model, Navier-Stokes formulation

Rainfall triggered landslides associated with residual soils in particular are a major natural hazard in hilly terrains. With heavy precipitation within a limited time, the groundwater table at such sites would surge, resulting in reduction in matric suction and hence the soil strength. Furthermore, soil stresses would increase due to soil saturation, thus creating favorable conditions for slope failures. Therefore, reliable and accurate methods of estimating threshold rainfall conditions that generate critical rates of groundwater surges in landslide prone areas would be invaluable. There are several empirical models which can predict the surge in groundwater table due to rainfall. However, an empirical model can be of limited applicability if it cannot be calibrated for soil and groundwater conditions of any given region. Furthermore, an empirical model does not consider the randomness in soil grain size distribution.

To address this problem, a groundwater flow model based on fluid dynamics, which can be calibrated for any given soil and groundwater characteristics and which considers the randomness in soil grain size distribution at a given site is developed. Of a variety of modeling methods available, this research focuses on a numerical model based on Navier-Stokes formulation. An initial parametric study was performed to produce useful prediction curves and the application was illustrated with a numerical example.
The Synthesis and Characterization of a Pd-Ni-Mg/ceria-zirconia catalyst for use in Low Temperature Methane Reforming

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Keywords: Power markets, MPEC, smart grids, emissions reduction, renewable energy.

The world’s energy demands are increasing at a rapid pace and fossil fuels are being depleted equally fast. Generating renewable types of energy is now a necessity. Biomass obtained from landfills provides a good carbon-neutral energy resource. Using heterogeneous catalysts and processes such as Fischer-Tropsch, fuels can then be obtained. Dry reforming produces synthesis gas (a mixture of carbon monoxide and hydrogen) from carbon dioxide and methane. Therefore, carbon dioxide and methane, as the two main components of landfill gases, can be converted to liquid fuels by employing the Fischer-Tropsch method. Reforming of methane readily occurs at high temperatures (>600°C); however, it is costly on an industrial scale. Designing a low temperature reforming catalyst with improved selectivity and stability is imperative.

To achieve these goals, several catalysts were synthesized and characterized. The support was synthesized using Ceria and Zirconia nitrate as precursor salts. Ceria/Zirconia mole ratios of 0.6:0.4 were used because literature agrees that it has a high surface area compared to ceria and zirconia alone. Metals such as Ni/Mg and precious metals can then be loaded onto the support to form a catalyst that can be tuned for low temperature dry reforming.

Previous studies have shown that noble metals such as palladium and platinum have exhibited high activity at low temperatures and best resistance to poisoning. Palladium with Ni, Mg promoters on a ceria—zirconia mixed oxide support and Pd/ Ce$_{0.6}$Zr$_{0.4}$O$_2$ was used for dry methane reforming. Temperature programmed reduction (TPR) experiments have shown reduction occurring at 140 °C. The catalyst was also characterized using BET to obtain the surface area and XRD to determine crystallinity. Preliminary reaction results have shown that Pd decreases the reaction onset temperature to 372 °C.
Hybrid Adsorption and Biological Treatment Systems (HABiTs) for onsite wastewater treatment

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Keywords: onsite wastewater, biological nitrogen removal, ion exchange, Hybrid Adsorption and Biological treatment systems (HABiTs)

Conventional septic systems treat over 30% of the wastewater produced in the United States. Although effective in the reduction of organics and pathogens, there is limited removal of nutrients, most specifically nitrogen. This research involves the design and implementation of Hybrid Adsorption and Biological treatment systems (HABiTs) to the conventional septic system. HABiTs comprises a two stage biofiltration process employing ion exchange/adsorption media and biological nitrogen removal processes. HABiTs aims to effectively reduce total nitrogen concentrations to below 10 mg/L and withstand transient flow, variation of nitrogen concentrations and idle times which often hinder conventional septic systems. The first stage of HABiTs involves two processes, ion exchange and nitrification. Ion exchange is the physical process where ions in the aqueous phase are exchanged with ions in the solid phase. The selection of an ion exchange material with high capacity for ammonium is crucial for HABiTs but other factors such as cost and site applicability have to be considered. For material selection, batch reactor experiments were performed on seven different materials to determine ammonium adsorption capacity in both the presence and absence of competing ions. Zeolite based materials clinoptilolite and vermiculite performed the best by removing 90% and 70% of the initial ammonium concentration in the absence of competing ions. In the presence of competing ions clinoptilolite excelled achieving at least 80% removal. Based on these results a column packed with clinoptilolite was constructed. The column operated on saturated conditions with a 4mL/min constant flow of 70mg/L ammonium chloride solution. Ammonium concentration in the effluent was below 10 mg/L after 72 hours of experiment time. After 216 hours ammonium concentrations climbed up to 70% of initial concentration. The column is now been tested under unsaturated conditions with a competing ion solution simulating the effluent wastewater of a septic tank.
The Effect of Future Urban Growth Scenarios on Drinking Water Embodied Energy in Tampa, Florida

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Keywords: Drinking Water, Energy, Urban Planning, Infrastructure

Water utilities must provide a reliable, safe drinking water to continually expanding urban centers. However, as cities face increasing economic and environmental pressure to minimize energy usage (and associated carbon footprint), utilities will have to reduce energy requirements of their water treatment and supply systems, while still meeting drinking water standards. In the United States, most urban areas rely on a centralized water treatment scheme. Water is extracted from a surface water or groundwater source, sent through a treatment plant, and finally pumped into a water distribution system. Energy is associated with pumping, operation of treatment unit processes, and the production of treatment chemicals. In addition, pipelines usually follow road design. Therefore, the implementation of urban growth paradigms such as sprawl or smart growth may also affect pipe layout, and thus the energy usage and carbon footprint associated with pumping water to certain locations. Accordingly, this study determines the embodied energy and associated carbon footprint of water for different future growth paradigms for the city of Tampa, Florida. Spatially oriented future water use maps were derived from several future development scenarios. These development projections included a business-as-usual scenario and three distinct smart growth scenarios. Next, this data was integrated into the water distribution modeling software, EPANET 2.0, to simulate Tampa’s distribution system. Results show differences in the embodied energies of drinking water in each scenario. The results obtained from this study as well as the calculation procedure will be useful to city planners as well as utilities in determining urban growth incentives that take into account future energy requirements and carbon emissions.
A Multiphysics Simulation of a Simplified Tri-reforming Reactor

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Keywords: greenhouse gases, Fischer-Tropsch synthesis reactor, Comsol

For the past decade, the United States has been producing approximately 250 million tons of municipal solid waste per year (US EPA), over 50 percent of which was discarded into landfills. The natural breakdown of these wastes leads to the production of about 100 million metric tons of methane and a nearly equivalent amount of carbon dioxide, both potent greenhouse gases. The most typical method for dealing with this gas release is to flare the methane (as methane has a greenhouse potential roughly 20 times that of carbon dioxide, CO₂ is often not processed), however this fails to capture the energy stored in the methane, thus doing little to offset the carbon footprint of the waste. Various methods and processes of reclaiming the energy produced by waste decomposition have been developed.

This research project is developing a combination of four of these processes in one system: a tri-reformer, using three reactions to produce syngas, and a Fischer-Tropsch synthesis reactor, which converts the syngas into hydrocarbon fuels. This presentation is a simulation and analysis of the tri-reformer stage, in which a temperature and flow profile while be made to model steady-state operation using Comsol. The information produced by this model can then be used to better project reactor sizing and heating in practical applications.
Improving Pathogen Destruction in Mesophilic Anaerobic Digesters

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Keywords: Renewable Energy, Geohelminth, International Sustainable Development, Biogas

Small-scale anaerobic digestion is being promoted in the developing world because of the benefits associated with improved sanitation and recovery of resources (methane gas, nitrogen and phosphorus) from domestic and agricultural wastes; however, ecosystems and human populations must also be protected from geographically specific pathogens that enter the digestion process. Through laboratory experimentation this study investigated the survival of the resistant pathogen, \textit{Ascaris suum}, in mesophilic anaerobic digesters and how to improve its destruction.

In this study six discretely-fed anaerobic digesters biodegrading swine manure at 35°C were operated at varying average solids retention time and cycle frequency to simulate a small-scale anaerobic digester that are commonly promoted in the developing world. Two experimental aerobic controls simulating ideal ova development conditions at 28°C and 35°C were also maintained. Using nylon mesh bags with a 35μm-pore size, viable \textit{Ascaris suum} ova (eggs) (selected because it is a highly resistant pathogen) were exposed to the reactor and control environments for up to forty days. During this time three experiments were conducted; the first examined how the ova progressed through their development stages in various treatments, the second determined how long undeveloped ova could remain viable for during their residence in the treatments, and the third determined how long fully developed ova survived in the treatments. The results of the first experiment revealed that ova in anaerobic conditions will not develop into infective forms, but ova in aerobic conditions do.

The results of the second experiment demonstrated that 24 days are needed to completely inactivate \textit{Ascaris suum} ova at 35°C in an anaerobic environment. In addition, an important finding from the second experiment was that ova exposed to anaerobic environments survived longer (24 days) than ova exposed to a similar aerobic environment (16 days). Finally, the third experiment showed that ova that had developed into an infective form before entering the anaerobic environment were destroyed faster (18 days) than the 24 days needed to destroy undeveloped ova. Because many household digesters (with an average solids retention time of 30 days) are not large enough to remove highly resistant pathogens at ambient conditions it is critical that the geographically appropriateness of resource recovery from waste treatment technologies is assessed if the sludge is to be used as a fertilizer for crops or discharged into the environment. Future research is needed to develop engineered systems that passively promote ova development without reducing the resource recovery potential of technologies such as the anaerobic digester.
Urban Agriculture the one Sustainable Solution

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Keywords: Urban Agriculture, Food Production, Sustainable Agriculture, Stormwater BMPs, Watershed Model Systems

The world population is likely to be over 10 billion by 2050 (Keilman, 2001; Pearce, 2011). This creates critical consumption impacts as the world population has become more urban than rural; by the mid-21st century the urban population is expected to double, seriously impacting the already unsustainable urban infrastructure systems (World Health Organization WHO, 2014).

Traditional food production processes are proving to be insufficient for this exponential human population growth, damaging our ecosystems with agro-chemicals and feeding into social marginalization. Urban Agriculture is a food production system which addresses environmental and socioeconomic issues associated with modern agricultural production and provides evidence as a sustainable path to creating healthier humans and restoring ecosystems. But how can we encourage Urban Agriculture? In April of this year, Moglia (2014) verified how Choguill (1995) summarized "three key drivers for uptake of Urban Agriculture in the world: ABILITY, NECESSITY AND OPPORTUNITY."

However, the majority of scientists continue to debate specific measures, including land areas, produce types and quantities, job creation, and especially water use. Urban Agriculture systems are described by these environmental and socio-economic elements that vary substantially based on geography and location. Aubry et al. (2012) notes that in cities the “political will and . . . adequate knowledge and methods – which, in turn, need the involvement of applied research” are critical to land use policy change to support Urban Agriculture. However, authors continue to complain how each new case study only represents one aspect specific to a location (Arku, Mkandawire, Aguda, & Kuire, 2012; Stewart et al., 2013; Thebo, Drechsel, & Lambin, 2014).

The primary discrepancy is researchers are too site specific not allowing comparison between sites. This paper introduces the new measure of social capital supporting the three key drives identified by Choguill (1995). These measures allow each application of UA to be compared holistically. Thus, in this location of Tampa, Florida the fundamental ABILITY afforded all residents is water, using Urban Agriculture as a BMP application. The NECESSITY is forced on the population by food desert polluted with GMOs and pesticides. This creates the OPPORTUNITY as the relationship we hold in understanding and using these resources at our disposal. Entrepreneurship provides measures for these aspects universal to all Urban Agriculture, as this research shows.
Experimental investigation of a solar assisted air conditioning unit

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Keywords: Performance analysis, Solar assisted air cooling, Numerical modelling, Experimental evaluation

The amount of electricity consumption for refrigeration and air conditioning has been estimated by International Institute of Refrigeration to be 15% of all electricity produced worldwide [1]. Furthermore, the energy consumption for air conditioning has been estimated to be 45% of the whole residential and commercial buildings [2]. For most cooling applications, there is a coincidence between peak seasonal and daily solar gain and peak seasonal and daily cooling [3]. Therefore using solar energy to replace or reduce the electrical energy used to produce cooling is a favorable research subject. There are new designs proposed to use solar energy to improve the cooling cycle performance and decrease the electricity usage.

The laboratory performance assessment of a commercial solar assisted Air Conditioning (AC) unit has been investigated. The AC unit consists of a conventional DX vapor compression cycle (VCC) which is integrated by an evacuated tube solar collector. The high pressure superheated refrigerant vapor from the compressor flows through the solar collector and by absorbing heat its temperature increases. The hotter refrigerant entering the condenser is claimed to result in more sub-cooling at condenser outlet and higher COP with respect to traditional vapor compression cycle. The AC unit is laboratory tested according to the ASHRAE Standard 37 [4] and ANSI/ARI Standard 210/240 [5]. The purposes of these standards are to provide test methods for determining the cooling capacity of unitary air conditioning equipment and the cooling and/or heating capacities of unitary heat pump equipment. Also, a computer simulation code has been developed to predict the performance of the unit under different working conditions.

The results obtained from the numerical simulation show a slight decline in the COP of the solar assisted AC unit. By 15°C increase in refrigerant temperature between the compressor outlet and condenser inlet compared to the conventional AC unit the COP of the cycle declines around 0.5%. Also, the experimental results do not show any improvements in case of solar assisted unit. Due to high temperature of the fluid in the pipes connecting the unit and the collector there is a heat loss in the piping system. If the solar radiation is not high enough to overcome this heat loss the solar collector and the connecting pipelines act as a part of the condenser. In this case, some of the load is removed from the condenser heat exchanger, and the COP of the cycle is improved slightly compared to the traditional VCC (COP = 2.23-2.35).
Research Category # 2: Materials Science, MEMS/NEMS, Nanotechnology, Biomedical, and Health
Shape-changing Hydrogel Induced Rapid Release of Tissue Modules

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Keywords: Tissue engineering, biomaterials, cell release, temperature responsive polymer

Scaffold based tissue reconstruction inherently limits regenerative capacity due to inflammatory response and limited cell migration. In contrast, a scaffold-free (bottom-up) method promises formation of functional tissues with both reduced adverse host reactions and enhanced integration. Herein, we present a new bottom-up approach of detaching tissue precursors on shape-changing poly-N-isopropylacrylamide (pNIPAAm) constructs based primarily on a mechanically driven process. Spontaneous release of viable tissues occurs upon thermal shift and shape change of the hydrogel around its volume phase transition temperature.

NIH-3T3 mouse fibroblast cells were cultured on patterned shape-changing pNIPAAm substrates. Reduction in cell culture temperature below its lower critical solution temperature facilitates cell detachment. The mode of cell release from hydrogel surfaces was examined by separately treating seeded samples, after 24 hour incubation, with 2 mM sodium azide, a compound known to block ATP production, 50 µM Y-27632, a selective inhibitor of Rho-associated protein kinases, or 2 mM DTSSP, a homobifunctional crosslinker that fixes only integrins bound to the extracellular matrix.

The release of geometrically patterned tissue modules from shape-changing hydrogel arrays occurs almost instantaneously via a critical strain of 25% (Fig. 1). For the tissue modules formed on pNIPAAm hydrogel, reducing metabolic activity by treatment with sodium azide had no detectable impact on tissue module detachment, in contrast to grafted pNIPAAm surfaces. While attached tissue modules treated with Y-27632 or DTSSP both prevented tissue module detachment for all strains tested (Fig. 1). These results suggest that the mechanism for detachment is strongly related to the degree of lateral strain from the anisotropic swelling of the hydrogel.

A purely mechanical, strain-based mechanism of detaching intact tissue modules from patterned arrays of shape-changing hydrogel structure was demonstrated. This novel approach establishes a rapid method for recovery of tissues in an efficient manner, which may be applicable for the modular, bottom up construction of tissues for organ models and regenerative therapies.
Novel Ion Funnel Created with a Flexible Circuit Board and a 3D Printed Housing

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\textbf{Keywords}: Mass spectrometry, thin film deposition, RF Ion Funnel, electrospray ionization, flexible circuit board, 3D Printer

RF ion funnels are important devices for focusing ion clouds at low vacuum conditions for mass spectrometry or deposition. Typically, ion funnels are constructed of stainless steel plate ring electrodes with a decreasing diameter where RF and DC potentials are applied to the electrodes to focus the ion cloud. To improve upon the costly and labor-intensive design of the conventional ion funnel, an innovative ion funnel fabrication technique has been developed and implemented.

The new design is created from a flexible circuit board that serves as both the signal distribution circuit and the electrodes of the ion funnel. The flexible circuit board is rolled into a 3D printed housing to create a funnel shape and uses copper traces on the flexible circuit board as the ring electrodes. Experiments were performed comparing the performance of the flexible ion funnel to the performance of the conventional ion funnel. These experiments suggest that the flexible funnel design functions equally as well as the conventional design and can serve as an inexpensive replacement.
Piezoelectric Electrospun Fibers

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Keywords: Electrospinning, Nanofibers, Piezoelectric

This research summarizes multiple studies done on the production of electrospun polyvinylidene difluoride fibers. Electrospinning is a production technique that is capable of producing large webs of nano to micro scale fibers. This study synthesizes and builds on previously reported by investigating the impacts of solutions parameters and processing parameters on the structure of fiber webs. There are many structural defects and processing concerns that occur during the production of electrospun micro and nanofiber webs. Defects in the fiber web structure can drastically alter functionality by reducing uniformity, reducing surface area, altering permeability, and changing the mechanical properties.

Currently researchers and manufacturers lack guidelines for producing structure controlled electrospun fiber webs without defects. By using appropriate experimental design we show that a variety of parameters are important for controlling the fiber diameter. This is visually apparent by examining SEM images taken of each sample. And we show that a variety of processing parameters are important for reducing the occurrence of defects in the fiber structure. A parameter based model is built and shows a high goodness of fit. The models are used to provide production guidelines for producing defect free fibers. This research also shows one possible application for defect free piezoelectric webs. A pressure sensing device is made using electrospun piezoelectric fibers and the voltage output is measured.
Presbycusis, Inferior Colliculus, Aldosterone

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Keywords: Presbycusis, Inferior Colliculus, Aldosterone

Aldosterone (ALD) is a mineralocorticoid hormone secreted by the adrenal cortex which plays a primary role in controlling sodium (Na+) and potassium (K+) serum levels within the peripheral and central auditory system. It has been shown that serum ALD levels decline with age in humans and other mammals. Deficiencies or imbalances between Na+/K+-ATPase, K+ channels and Na-K-Cl cotransporter in the cochlea have also been observed to cause morphological and functional changes on cells downstream in the K+ recycling pathway, leading subsequently to hearing loss. A causative role for ALD in age-related hearing loss has yet to be demonstrated; however our group discovered a link between low serum ALD and severity of presbycusis in elderly humans. While extensive work has been conducted exploring the effects of ALD within the peripheral auditory system, the effects of ALD treatment on the central auditory system have yet to be investigated. The goal of this study was to assess the long-term therapeutic effect of ALD treatment on neural processing of inferior colliculus (IC) auditory midbrain neurons in aged mice.

We investigated the effects of ALD treatment (1.67 μg per day via a 120 day slow release, subcutaneous pellet) on the receptive fields (RFs) and the temporal processing abilities of IC neurons in age-paired control and treated mice. Multi-unit activity was assessed via analysis of the changes in RFs based on the minimum response threshold (MT) and width of tuning (Q10 & Q40), with the tonotopic axis divided into low, mid and high frequency regions. Temporal processing was measured using a gap-in-noise signal from which minimum gap thresholds were derived. Following ALD treatment, a significant positive effect for both RFs and temporal processing was observed, as well as a significant improvement in mean MTs of 11, 14 and 17 dB for the three frequency regions, respectively. Tuning was also affected by ALD treatment, evident by a broadening of RFs for Q10 for all regions and Q40 values for high BFs. There was no effect of treatment on the proportion of response types observed. These results suggest that ALD alters RF properties, with improvements in absolute sensitivity, and temporal processing abilities of IC neurons in aging CBA mice. Changes in MCR expression and function may be a contributing factor to central auditory processing deficits found in aged listeners. Furthermore, these results are the first to indicate a role of MCR in neural correlates of temporal processing. The results point to a potential target for future therapeutic interventions to prevent or slow down the progression of age-related hearing loss.
Fabrication of Shape Shifting PNIPAAM Stamps for Cell Printing and Alignment

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Keywords: PNIPAAM, poly-isopropylacrylamide, Cell printing with multiple layers, Tissue Engineering

Tissue engineering offers the promise of repair of diseased or damaged organs. Conventional tissue engineering using scaffolds cause adverse effects such as inflammation at the implantation site, host rejection of the scaffold, and poor cell organization and cell proliferation. Assembling patterned cell sheets without the use of scaffolds has the potential to overcome these limitations [1]. We fabricated stamps consisting of arrays of micro-beams made from poly-N-isopropylacrylamide (PNIPAAM), a thermo-responsive polymer, to test the hypothesis that shape-shifting surfaces can be used to control cell organization into tissue modules and direct intact tissue module release during contact printing. The geometry and thermo-responsive swelling of these stamps cause them to rapidly change shape, and the dimensions of the micro-beams can regulate cell attachment, cell alignment and cell-to-cell connections to mimic native tissue structures [2].

The shape shifting stamps are made by photopolymerizing a PNIPAAM polymer mixture within a PDMS master mold to form the desired micro-beams on surface-activated coverslips. Then, NIH3T3 mouse fibroblasts are seeded onto the sterilized micro-beams. After 24 hours, the confluent cells are released or contact-printed onto target surfaces by using the shape-shifting properties of the stamps induced through temperature manipulation. The impact of release and printing on the viability and alignment of tissue modules are then analyzed.

Release and contact printing was observed to depend on the surface expansion of the microbeams. Cell viability and transfer efficiency were influenced by pressure and stamp patterns. The results suggest that the reduction of pressure during micro printing significantly increases cell viability and closely spaced patterns in the micro-assays provides optimal tissue module alignment.

Overall, the micro-patterned sheets are capable of printing viable 3D tissue structures. The patterned assays that localize the cells upon their release separate this research from other cell sheet technologies. Future research involves optimizing the pressure applied during micro printing to maximize cell viability and transfer efficacy. In addition, we will investigate more complex pattern geometries and the assembly of tissue building blocks via contact printing to mimic native tissue structures.

Walking Crutch/Cane for Enhanced Assistance, Balance and Control of Walking Dynamics

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Keywords: crutch, cane, kinetic shape, gait, dynamics

In this poster a proposed design for crutch/cane tips is presented that passively assists users during walking while enhancing control and balance. According to the Disability Statistics Center at the University of California, 6.1 million Americans living outside of institutions use crutches, canes, or walkers for mobility assistance and more than 10 million Americans use crutches due to temporary leg or foot injuries. The current design of crutches and canes has changed little throughout their long history of use. Today’s familiar crutches resemble those used during the late eighteenth century and users are still reporting issues with comfort and an inability to walk long distances. The lack of attention to crutch design has resulted in very similar tips all with symmetric constant radius shapes.

Our recent research on “kinetic shapes” allows us to specify the shape of a crutch/cane tip that can generate a rolling force based on a vertical weight applied by the user. When loaded with a known weight, these kinetic shapes will produce a desired ground force parallel to the flat plane. The ratio of transmitted vertical to horizontal force is determined by the radial change. These crutch/cane roll over shapes can either be passive and predetermined or actively changing shapes adjusting to walking environment or desired crutch dynamics.
Antennas Miniaturization by Using a High-k and Low-loss Polymer-Ceramic Engineered Substrates

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**Keywords:** Antennas, dielectric loss tangent, flexible substrates, high-k dielectrics, polymer-ceramic composites

In this work, a new class of mass-producible high-k, low-loss and compliant polymer-ceramic composite materials have been thoroughly investigated, which is a promising enabler for the next generation of 3D conformal RF and microwave devices while extending the range of printable materials in additive manufacturing. A systematic approach has been used to develop and characterize high-k, low-loss and bendable substrates for microwave device applications, by dispersing high-permittivity ceramic particles into silicon rubber (PDMS Sylgard 184). Eight different PDMS-ceramic composites were prepared by mixing two kinds of high-k ceramic microparticles, such as: Mg-Ca-Ti (MCT140) from Trans-Tech Inc., and Neodymium Titanate, Ultra-Low Fire (ULF990) from Ferro Corporation, into PDMS resin at varied volume concentrations (10%, 20%, 25%, and 30 %). At the low frequency band between 0.4GHz and 4.4GHz, 25 v/v% loaded PDMS-MCT140 composites have shown a promising dielectric response with permittivity ($\varepsilon_r \sim 8.7$) and loss tangent ($\tan\delta_d < 0.0137$). The same composite substrate has exhibited measured permittivity ($\varepsilon_r \sim 7.07$) and dielectric loss tangent ($\tan\delta_d < 0.0279$) at the high frequency band between 6.2 GHz to 19.4 GHz. Similarly, 25 v/v% PDMS-ULF990 composites have shown $\varepsilon_r \sim 8.24$ and $\tan\delta_d < 0.0104$ at the low frequency band and $\varepsilon_r \sim 6.23$ and $\tan\delta_d < 0.02581$ at the high frequency band. Overall, the loss properties of these composite substrates are on par with that of the widely used FR4 printed circuit board ($\varepsilon_r \sim 4.3$ and $\tan\delta_d < 0.022$).

Five microstrip patch antennas were designed and measured to evaluate the microwave properties of the engineered composite substrates at 2 GHz and 4 GHz. In particular, the antenna implemented on a 25v/v% PDMS-MCT140 substrate at 4 GHz has achieved a size reduction of 43% while retaining a bandwidth of 98 MHz (2.45%) and a measured antenna gain of $\sim 5.0$ dBi which are both on par with those of the reference design on FR-4 printed circuit board (i.e., bandwidth of $\sim 3.15$% and gain of $\sim 3$dBi). Similarly, the antenna implemented on a 25v/v% PDMS-MCT140 substrate at 2 GHz has achieved a size reduction of 43%, a bandwidth of 31 MHz (1.51%), and a measured antenna gain of $\sim 3.0$ dBi, which are on par with those of the reference design implemented on FR-4 printed circuit board (bandwidth of $\sim 2.0$% and gain of $\sim 1.3$dBi). Overall, this research has great potential to fill the critical knowledge gap between synthesis of functional materials and their incorporation into the 3D structural electronics, thereby enabling additive manufacturing the next-generation of 3D RF and microwave devices with well-tailored optimum performance characteristics.
Acoustic Force Effects on Cell Viability and Patterning

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**Keywords**: Acoustics, Cell Viability, attachment strength

Manipulation of micro-particles, such as mammalian cells, therapeutic carriers, or microorganisms, has many important applications in the study of life sciences and in biomedicine. Previous studies have shown that micro-particles can be manipulated and positioned using acoustic forces. However, acoustic force required for cell detachment and overall viability has not been addressed.

This study investigates the effects of amplitude and energy of acoustic force on cell viability and attachment in vitro. A probe style sonicator with microtip attachment was used to produce the acoustic force and a signal generator was used to control the output power and duration of the force. Adherent cells were then subjected to this force for a specified period of time and their attachment and viability were analyzed using fluorescence microscopy. This work was supported by the National Science Foundation under CAREER DMR \# 1056475, CBET \#1135419 and the Graduate Research Fellowship Program (GRFP).
Fabrication and optimization of CoO-ATO nanofibers

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**Keywords**: Electrospinning, nanofibers, thermally reflective materials

This work investigates the fabrication, process optimization, and characterization of cobalt oxide-antimony doped tin oxide (CoO-ATO) nanofibers using polystyrene (PS) solutions with toluene or D-limonene as solvents. These nanofibers are produced by an electrospinning process. Nanofibers are fabricated using polymeric solutions of CoO doped ATO and mixtures of PS: D-limonene and PS:toluene. PS is a base aromatic organic polymer, a non-toxic material, and a versatile catalyst for fiber formation. PS solutions are made by mixing polystyrene beads and D-limonene or toluene at specific weight percentages. These polymeric solutions of PS: D-limonene and PS: toluene are then mixed with CoO-ATO at various weight percentages. The two solutions are electrospun and the best process parameters optimized to obtain nanofibers with limited beading. Process optimization is completed by analyzing how changes in the electrospinning experimental set up impact nanofiber formation and production efficiency (speed of formation). CoO-ATO nanofibers are characterized by scanning electron microscopy, hydrophobicity via contact angle measurements, and viscosity measurements.

Additional analysis was conducted to evaluate the environmental impact of using two different solvents to fabricate the CoO-ATO nanofibers. In this project, we were able to successfully produce novel nanofiber membranes of CoO-ATO using two different solvents. These investigations were conducted and nanofiber process optimized to provide a technological contribution to future industrial scale productions of thermally reflective materials.
Microfluidically Controlled High Resolution Low Cost mm-Wave Surface Imaging System

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Keywords: Metallized plates, RF read out circuit, Complimentary spiral resonator

Microwave imaging has progressively found its application in varied fields such as breast cancer screening on account of its non-destructive and non-invasive diagnostic capabilities. Such imaging techniques are also being employed to investigate surface properties such as metal fatigue/cracks, and device wafer dielectric characterization. Commonly used imaging configurations observe the interaction of the sample with microwaves and then use the scattered fields for reconstructing the image. Scanning imaging systems measure the amplitude and/or phase values of the reflected signals from the sample and post process the variations to determine the material properties.

To reduce the post processing complexity, the imaging system presented in this poster uses the shift in resonant frequency of a complementary spiral resonator (CSR) when loaded with the sample to be imaged. The pixels of the envisioned imaging system are formed as a dense array of sub-wavelength size slot spiral resonators etched at the ground plane of a microwave substrate. The resonance frequencies of these resonators shift based on the dielectric properties of the material sample within their close proximity. Interrogation of the resonance frequency of each resonator is done by utilizing metalized plates as RF shorts between read-out microstrip lines and resonators. The metalized plates can be repositioned within the microfluidic channels by use of a single micropump unit to sequentially interrogate resonance frequencies of all pixels to extract an image. The concept is introduced through simulations and experiments carried over a 1D material sample. An example 2D imaging system is also presented (through computational simulations) for imaging of tumorous excised breast tissue. The proposed technique alleviates the needs for expensive/complex RF switch based interrogation circuitries or bulky/slow mechanical raster scans.
Supramolecular Self-Assembly of Multilayers of 2D Metal Organic Frameworks Thin Films

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Keywords: Metal Organic Frameworks, 2D thin films, Crystal engineering, Density of States, Photoemission Spectroscopy, Density Functional Theory, Surface Science

Metal Organic Frameworks (MOF) deposited from solution has the potential to form supramolecular 2D thin films suitable for molecular electronic applications. The main challenges are in achieving selective attachment to the substrate surface, and the integration of organic conductive ligands.

MOF multilayer thin films were grown on functionalized Au substrates via incubation in a glove box. The electronic structure of the resulting interfaces as well as the chemical interaction were characterized by Photoelectron emission Spectroscopy (PES). A porphyrin derivative, 5,10,15,20-tetrakis(4-carboxyphenyl)Porphyrin (TCPP), in combination with Cu(NO₃)₂ metal centers, which served as bonding units between the carboxylic acid ligands of the porphyrin were self-assembled on an Au substrate functionalized with 4-Mercaptopyridine (4MP). The growth process was carried out in several steps. In between individual steps the surface was characterized by photoemission spectroscopy. Low Intensity X-ray Photoelectron Spectroscopy (LIXPS) revealed the corresponding work functions of the materials. Ultraviolet Photoelectron Spectroscopy (UPS) with the correlation of Density functional theory (DFT) calculations of the theoretical Density of States (DOS) provided information about the Highest Occupied Molecular Orbitals and Lowest Unoccupied Molecular Orbitals (HOMO and LUMO respectively). The nature of the supramolecular overlapping orbitals of individual elements was determined, enabling the determination of the electronic structure of the metal/supramolecular interface. In addition, X-ray Photoelectron Spectroscopy (XPS) system gave insight into the chemical interaction at the interface and allowed the estimation of the thickness of the fabricated film.

Two additional control experiments using UPS, and XPS proved that there was no significant growth after a sequential incubation of the functionalized Au substrate in the solution of both metal ions and organic ligands assumingly due to the mutual host-guest interactions had already occurred in that solution. Furthermore, the TCPP molecules did not self-assemble on the surface of 4MP without the initial deposition of the metal centers. This might be attributed to the pH-dependent electrostatic binding between the SAM and the organic ligands. This was due to the absence of metal ions which were essential to stabilize the ligand networks and constructed the MOF nano film.
Assessing Viscoelastic Properties of Polydimethylsiloxane (PDMS) Using Loading and Unloading of the Compression Test

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Keywords: mechanical properties; elastic modulus; viscosity and viscoelasticity

Polydimethylsiloxane (PDMS) mechanical properties were measured using custom-built compression test device. PDMS samples with variable cross-linking density were prepared with the elastomer base to the curing agent ratio ranging from 5:1 to 33:1. The PDMS elastic modulus varied linearly with the amount of cross-linker, ranging from 0.57 MPa to 3.7 MPa for the tested samples. The compression device was modified by adding digital displacement gauges to measure lateral strain of the sample, which allowed obtaining the true stress strain data. Since the unloading behavior was different than the loading behavior of the viscoelastic PDMS, it was utilized to assess viscoelastic properties of the polymer. The poster describes a simple method for measuring mechanical properties of soft polymeric materials.
Polyhexylthiophene with Boron Nitride hybrid blend photoelectrochemical cell

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Keywords: Photochemical, nanodiamond (ND)-ragioregular polyhexylthiophene (RRPHTh)

Recently, we have studied the photoelectrochemical properties of nanodiamond (ND)-ragioregular polyhexylthiophene (RRPHTh), ND- poly (3-dodecylthiophene), another derivative of polythiophene [1-4]. The photocurrent of 8 to 20 times has been observed in the nanodiamond ND (RRPHTh) nanostructured blend film systems than most of nanoparticles containing RRPHTh blend films. Under this investigation, the effect of various sizes of (ND) from micro to nano for nanostructured blend with RRPHTh conducting polymer has been studied. It has been observed that the nano-diamonds (ND)-RRPHTh showed increased photovoltaic efficiency than micro-diamonds (MD)-RRPHTH based blend films.

Further, the photoelectrochemical properties of boron nitride blend with RRPHTh has been studied. The boron nitride (BN) with similar characteristics as diamond has now gained interest in the mechanical and optical fields. The UV-vis spectroscopy, FTIR spectroscopy, and SEM properties of blend films were studied and compared. The electrochemical properties such as cyclic voltammetry, chronoamperometric, impedance spectroscopy with and without light were studied. The ND-RRPHTh and BN-RRPHTh hybrid based photoelectrochemical cells were studied and compared for short circuit current, power conversion efficiency ($\eta$) and fill factor. Our work shows for the first time the use of boron nitride for polythiophene based photovoltaic devices.
Selective Enhancement of Macropinocytosis for Treatment of Lung Cancer

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Keywords: Macropinocytosis, non-small cell lung cancer (NSCLC)

Macropinocytosis is a type of endocytosis that has been mentioned as a possible cargo delivery mechanism. This actin-driven process consists of the ruffling of the cell membrane which allows for capture of particles in the cell proximity. We evaluated the possibility of selectively enhancing this mechanism in non-small cell lung cancer (NSCLC) overexpressing the keratinocyte growth factor receptor (KGFR) to deliver a proapoptotic peptide (PP), (KLAKLAK)2. For this purpose, we used a platform that consisted of two fusion proteins: (KLAKLAK)2 fused to elastin like polypeptide (ELP) and the keratinocyte growth factor (KGF) also fused to ELP. ELP backbone is found at the core of the platform while the GF and PP domains are found at its periphery.

The fusion proteins were produced recombinantly in bacteria. The expression of the KGFR in different cell lines including lung adenocarcinomas and pancreatic cancer cells was quantified using RT-PCR. The internalization of the platform by cancer cells was analyzed by flowcytometry. The internalization mechanism was analyzed by using blockers for receptor mediated endocytosis and macropinocytosis, chlorpromazine and amiloride, respectively. In addition, different formulations containing varying concentrations of KGF-ELP and (KLAKLAK)2-ELP were tested to find the best cytotoxic formulation.

The major internalization mechanism was found to be macropinocytosis (Fig. 1, Left). Lung adenocarcinoma cells (A549) and pancreatic cancer cells (Mia PaCa-2) were treated with our platform. A549 cells overexpress KGFR while Mia PaCa-2 cells do not. Our results clearly show that killing in A549 cells is improved when KGF-ELP is part of the platform. High concentration of KGF-ELP however dissipates the killing effect of our treatment; we believe this occurs because at high concentrations of KGF-ELP, the proapoptotic peptide becomes too diluted to be effective. Mia PaCa-2 cells do not show any killing (Fig.1, Right).

Our results indicate that macropinocytosis is selectively enhanced in cells overexpressing the KGFR. Enhanced macropinocytosis translates improve internalization and killing by the PP. Therefore, this platform represents a promising approach for developing a targeted therapy that enhances internalization of cytotoxic agents. This strategy is extremely versatile and can be expanded for targeted treatment of other cancer types as well as other diseases that may require improved delivery of cargo.
Tribological and Mechanical Behavior of Nanostructured Al/Ti Multilayers

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Keywords: Al-Ti, multilayer, nanowear, hardness, nanoindentation, XRD, TEM, shear band, twin, work hardening

Nanoidentation and nanowear tests were performed on sputter-deposited Al/Ti nanostructured multilayered films (NMFs) with individual layer thickness of 2.5 and 30 nm. Microstructures of the NMFs were characterized using XRD, AFM, SEM, TEM, and orientation mapping. Decreasing the layer thickness from 30 to 2.5 nm leads to an increase of hardness from 3.46 to 5.59 GPa. Nanowear tests of the multilayers were carried out at 30, 60 and 93 µN normal loads and up to 10 cycles of wear. For both NMFs, the wear rate increases with applied load and decreases with hardness. Nanoindentation tests on the worn surface revealed work hardening of the subsurface material. Transmission electron microscopy analysis revealed extensive severe plastic co-deformation of the Al and Ti layers.
New Type of Anode Materials for Lithium Ion Batteries (LIBs)

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Keywords: Thin films, Adhesion, Nanoindentation, Lithium Ion Battery

Lithium Ion Batteries (LIBs) have gained increasing popularity due to its high potential, low self-discharge, zero priming and minimum memory effect. However, the emergence of electrical vehicles (EV) and hybrid electrical vehicles (HEV) in the automobile industry, where LIB was predominantly in use, instilled a need to improve LIB batteries by experimenting with new materials. Today’s LIBs mostly use graphite as an anode material, which suffers from low theoretical capacity and torpid rate performance. Germanium (Ge) seems to be a promising substitute of carbon due to its high theoretical capacity, high Li+ diffusivity and electrical conductivity. However, Ge undergoes large volumetric change (+-370%). This causes deboning of the thin film Ge electrode from the substrate current collector, causing a rapid decrease in the electrolytic performance. The process of Ion Beam Mixing claims to have overcome this problem.

In our current study, the adhesion strength of Ge thin film over Nickel (Ni) substrate (with and without ion beam mixing) is being measured using Nanoindentation and Superlayer indentation test. Nanoindentation is one of the popular techniques to measure the mechanical properties and adhesion of thin film coatings. In this technique, a very small indenter of a desired geometry indents the film/substrate pair and the work of adhesion is calculated knowing the plastic depth of indentation and the radius of indentation. Superlayer indentation is analogous to normal indentation but with a highly stressed superlayer on top to restrict out-of-plane displacements, it reduces the plastic pile up around the indenter tip. The results from our study strongly suggest the possibility of dramatically increasing the adhesion strength by ion bombardment, which can be achieved by atomic level intermixing of the film/substrate pair. These, in turn, suggest that Ge can be an effective successor to graphite in the near future.
Development of Recombinant Functional Biomaterials For Neuronal Regeneration

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Developing a novel approach to growth factor delivery for nerve regeneration will be useful in tissue engineering as well as increase quality of life to those with Spinal Cord Injury, Traumatic Brain Injury, and neuronal injuries. Neuronal injuries pose a major health problem among young adults ages 15 to 24 and people of ages 75 years and older and can impact the quality of a person’s life. Due to the limited regenerative capacity of the nervous system, treatment options are severely limited and are unable to restore complete function to these patients.

Neurotrophins such as nerve growth factor (NGF) and brain-derived neurotrophic factor (BDNF) play a major role in the development and maintenance of the nervous system. NGF and BDNF are promotion growth factors that will induce neural regeneration and axonal differentiation. They also have been noted to provide an increase in motor and sensory function. NGF have been shown to improve the outcome of neural injuries in several pre-clinical models, but their use in clinics is limited due to lack of robust delivery systems that ensure increased bioavailability of the neurotrophin at the injury site. Current methods that involve simple injections of the neurotrophin result in low bioavailability due to loss of the neurotrophin because of diffusion. Consequently, repeated applications are necessary to see a clinically beneficial effect rendering the therapy expensive.

Our approach is to create a recombinant functional biomaterial that can not only ensure sustained delivery of the neurotrophin but also provide a unique topographical scaffold surface at the injury site: specifically, a fusion protein comprising of a neurotrophin and elastin like peptides (ELPs). Elastin-like peptides (ELPs) have uniquely tunable phase transitioning properties that allow the fusion protein to undergo molecular self-assemblies into different nanostructures in response to the changes in their environment (e.g. pH or temperature). ELPs are soluble in aqueous solution below their transition temperature (Tt) however, when the solution temperature is raised above their transition temperature, ELP will self-assemble into an aggregate rendering it insoluble. These nanostructures will allow controlled spatio-temporal delivery of the biologically functional factor to the injury site where they can stimulate regeneration. Thus, at the injury site this functional material will act as a “drug depot” ensuring the sustained delivery of a neurotrophin.
An Interim Analysis of Body Powered Prosthetic Terminal Devices

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Keywords: prehensors, Voluntary closing (VC) terminal devices, voluntary opening (VO) alternatives, activities of daily living (ADL).

Body powered prostheses allow upper extremity amputees to control prehensors without the assistance of an external power system. Various prehensors can be attached to the prostheses and are controlled manually with a harness system through scapular abduction. Although 85,000–90,000 people have lost an upper limb in the United States, only a small percentage are using a prosthesis mostly due to the limited function and flexibility the current devices provide.\textsuperscript{1} Voluntary closing (VC) terminal devices are thought to provide enhanced proprioception, kinesthetic awareness and grip forces compared to voluntary opening (VO) alternatives. This study directly compared the function of VC and VO devices during a series of tasks and activities of daily living (ADL).

Subjects: Nine able-bodied males, and one able-bodied female used VO and VC with a prosthetic simulator. Seven males and one female with a transradial amputation (TRA) used both the VO and VC prehensors with a body-powered prosthesis.

Apparatus: An 8 Vicon (Englewood, CO) camera motion capture system with 29 reflective markers placed at specific points on the subject’s body were used to track the subject’s motion. The completion time of each task was recorded.

Procedures: The University of South Florida’s Institutional Review Board approved the protocol and each subject was asked to complete a consent form. Subject’s then completed a unilateral lift, bilateral lift, Box and Blocks test, a towel fold, and a cutting task.

Data Analysis: Marker locations were used to define a forearm and an upper limb segment and the elbow joint angles were calculated as the relative orientation between these two segments using Euler angles. The elbow range of motion (ROM) was calculated by subtracting the minimum angle from the maximum angle. This determined the flexion (positive) angle and extension (negative) angle. The sternal linear displacement was also measured in the medial lateral direction from right (positive) to left (negative) in relation to a fixed point.

The results showed the VC prehensor to allow for a larger elbow ROM. This suggests the VO prehensor may limit elbow motion. There was also shown to be less linear sternal displacement in the majority of tasks when using the VC prehensor. This suggests when using the VO prehensor, the subjects had to depend on trunk movement to compensate for the limited function in order to complete the tasks. Future work will involve further data analysis. These interim results show that the VC prehensor allowed for a greater elbow angle ROM and is less limiting compared to the VO design. When using the VC prehensor, subjects used less medial-lateral trunk movement to complete the tasks.
Design and Implementation of MEMS based Oscillator

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Keywords: MEMS, Oscillator, Resonator, Sensor, High Q, Wireless Communication

In modern wireless communications, a frequency-reference oscillator is a very important frequency-setting component in any wireless transceiver systems. Traditionally, off-chip quartz crystal oscillators have been the most widely accepted choice despite its low level of integration with IC’s and limited frequency range up to 100MHz. The advent of high-Q MEMS resonators has enabled the on-chip MEMS based oscillators to be fully integrated with IC sustaining amplifier thus exhibiting a promising low phase noise at much higher frequencies than that of the quartz crystals. Furthermore, the MEMS oscillator can be readily implemented as a highly resolution gas sensor by monitoring the correlation of the added mass of the absorbed gas analyte and resultant frequency shift. Meanwhile, MEMS technology fuels further miniaturization and seamless integration of passives and various transistor integrated circuit technologies.

In this poster, an oscillator technology with high-Q MEMS resonator as its tank circuit is presented to validate its key functionality as a stable frequency reference across a wide spectrum of frequencies. Particularly, two piezoelectrically transduced MEMS resonators fabricated within a single chip are strategically designed to operate at two distinct layout-defined mechanical modal frequencies (259.5MHz and 436.7MHz). These devices were characterized and modeled by an extracted equivalent electrical circuit to facilitate the design of the oscillator using a standard circuit simulator. For this preliminary study, the MEMS resonators are integrated with the sustaining amplifier circuit using wire-bonding technique and coaxial connectors. As shown by the time-domain measurements, these oscillators are capable of locking into the resonance frequency of the constituent MEMS resonator to generate a stable sinusoidal waveform with peak-to-peak amplitude of 4.6V at 259.5 MHz and 2.3V at 436.7 MHz, respectively. On the other hand, the fundamental oscillation frequency and it harmonics can be easily observed in a measured frequency-domain spectrum. The phase noise performance is going to be rigorously investigated, which is anticipated to be on par with that of the best off-chip quartz crystal counterparts. In order to fully take advantage of this technology, low-cost and customizable integration between MEMS resonator and IC chip is going to be explored in the future by employing novel approaches, such as fan-out wafer level packaging and 3D printed interconnects.
Purification and Characterization of Epidermal Growth Factor Fusion Protein

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Keywords: Epidermal growth factor, Elastin-like peptide, Inverse transition cycling

Overexpression of the epidermal growth factor receptor (EGFR) is present in many types of cancers, including lung and colon cancer. This receptor can be targeted using epidermal growth factor (EGF) to selectively target cancerous cells for cancer treatment. This varies from common forms of cancer treatment, such as chemotherapy and radiation, because they kill cancerous cells along with healthy cells. It is the damage done to healthy cells which causes many of the negative side effects associated with cancer treatment, such as hair loss, nausea and vomiting, and infertility. Hence, utilizing the overexpression of EGFR in many cancer cells can be a useful method for cancer treatment, while avoiding many of the harmful side effects associated with traditional cancer treatment.

In order to produce EGF, it was fused to an elastin-like peptide (ELP). ELPs are a series of hydrophobic pentapeptide sequences of (VPGXG)n, where X is any guest residue with the exception of proline, and n is the number of pentapeptide sequences. The EGF-ELP was produced utilizing recombinant DNA technology, while protein expression was carried out in E. coli bacteria. In order to separate the EGF-ELP from cellular debris, a process known as inverse transition cycling (ITC) is used. ITC takes advantage of a property that ELPs possess called a transition temperature. Above this transition temperature, the EGF-ELP fusion becomes insoluble and precipitates out of solution and can be separated from soluble cellular debris using a centrifuge. When below this temperature, the protein becomes soluble and can be separated from insoluble cellular debris via centrifugation. This process was successfully carried out for the purification of the EGF-ELP fusion protein, and was verified using western blot analysis. Dynamic light scattering (DLS) was then used to confirm that the EGF-ELP fusion protein did transition, and to characterize the size of the fusion protein. Furthermore, the EGF-ELP fusion has been shown to retain the biological activity of EGF meaning it has the potential to be used as a therapeutic for cancer treatment.
An objective neural assay for detecting tinnitus in animal models

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**Keywords**: tinnitus, auditory brainstem response, rodent, signal processing

Chronic tinnitus, or “ringing of the ears”, affects upwards of 15% of the adult population. Identifying a cost-effective and objective measure of tinnitus is needed due to legal concerns, disability issues, and to assess neural biomarkers. Pre-pulse inhibition (PPI) of the acoustic startle response (ASR) utilizes silent gaps inserted in tonal noise and is commonly used to identify tinnitus in rodents. It is hypothesized that tinnitus “fills in” the silent gap when the noise carrier is near the tinnitus pitch. However, this method is subject to behavioral changes due to animal stress levels. In addition, a robust ASR is also necessary, and when the ASR is of low amplitude animals which may be experiencing tinnitus cannot be evaluated. It has also been reported that transient unilateral conductive hearing loss impairs the gap-PPI, indicating the risk of a false positive assessment of tinnitus using gap-PPI.

We developed a modified gap-in-noise (GIN) paradigm to assess tinnitus in mice using the auditory brainstem response (ABR), an acoustically stimulated electrophysiological signal that represents activity from the cochlea, auditory nerve, and brainstem. We compared the ASR gap-PPI and the ABR GIN paradigm using noise bursts (NB) centered at 6, 12, 16, 20, 24, and 36 kHz in 12 young adult CBA/CaJ mice before and after administrating sodium salicylate (SS), which is known to reliably induce a 16 kHz tinnitus percept in rodents. Post-SS, gap-PPI was significantly reduced at 16 kHz, consistent with the literature. ABR audiogram responses indicated reduced input from the auditory nerve/cochlea, and despite this, an increase in activity from more central auditory structures. This observed hyperactivity was significantly correlated with behavioral indications of tinnitus in response to 16 kHz stimuli. For the GIN ABR, peak 1 (P1) amplitude for the NB2 response was calculated as a % of the NB1 amplitude to quantify the neural response in gap processing; a significant decrease in this ratio was seen only at 16 kHz, indicating the presence of tinnitus near this frequency. The GIN ABR proved to be an efficient, non-invasive, and objective method of identifying the approximate pitch and presence of tinnitus in a mouse model. This technique has the potential for application in human subjects and also indicates significant, albeit different, deficits in temporal processing in peripheral and brainstem circuits following drug induced tinnitus.
Health Information Exchange: The impact on clinical care at Tampa General Hospital using a mixed methods approach

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Keywords: Health information exchange; medical records linkage; health information systems.

In the United States, 125 million people live with chronic conditions and most of them receive care from multiple providers. For these patients, care coordination is a necessity. Without care coordination, patients may undergo avoidable procedures, receive contraindicated treatments, and incur unnecessary costs. To foster care coordination, federal incentives have been in place since 2009 to increase health information exchange (HIE). HIE is the electronic movement of health-related information among health care organizations using computerized systems, as an initiative to facilitate a safe, timely, efficient, effective and equitable delivery of care. Recent studies have evaluated the effect of HIE in improving the delivery of care in emergency departments. However, there is a dearth of literature assessing the effect in other divisions, such as internal medicine departments.

The objective of this study was to define the current state of operations to obtain outside records at a hospital pre-HIE implementation, and to determine the effect of having outside health information on patient outcomes, hospital quality measures, and clinician workflows for an internal medicine department. Our central hypothesis was that the use of HIE systems during hospital stays improves the quality and cost of health care delivery. The rationale for the proposed research is that, once the current utilization of outside records is better understood, more suitable HIE systems will be developed.

By using mixed methods we were able to map the current process, define provider perceptions of pre-HIE implementation and HIE future implications, and compare those perceptions to quantitative data. Our results indicate that the process to request and retrieve outside medical records comprises 9 steps, 6 decision points, 1 loop and 4 participants. Mean time to request and retrieve information is 18 hours and ranges between 1 and 72 hours. Fourteen percent of patients admitted generated a request outside records to Florida Hospital, Memorial Hospital, St. Joseph’s Hospital, Moffitt Cancer Center, among others. Most important reasons to request outside records were knowing previous patient workup or treatment, reconciling medication, comparing lab abnormalities, and understanding disease stability. Majority of physicians review outside records on paper instead of electronically because viewing electronically results on “excessive clicking” and “does not facilitate parallel tasking”. Most physicians held positive expectations with HIE future implementation, however, they recognize that “it most be done in the correct way”. Future work includes studying information needs during inter-hospital transfers and determining the effect of provider access to relevant outside information on patient length of stay and number of labs, imaging, and procedures performed.
BMP-2-ELP Induces Differentiation of Mesenchymal Stem Cells to Osteoblast Lineage

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Keywords: morphogenetic proteins, Elastin-like peptides (ELPs), genetically encodable, biodegradability.

Current bone regeneration techniques utilize the application of bone inductive agents such as bone morphogenetic proteins to specific injury sites. Upon application, rapid-burst release of these drugs from the injury site have produced excess and unwanted bone growth in other areas of the body, making these unmodified drugs unideal. Elastin-like peptides (ELPs) are repetitive polypeptides in the form VPGXG, where X can be any amino acid except for proline. The use of ELPs as a drug-delivery vehicle has been an object of recent interest due to their ability to be genetically encoded, their inverse solubility at natural body temperature, and their biodegradability. Since ELPs are genetically encodable, their length and sequence can be controlled, and the aforementioned morphogenetic proteins can be fused to ELPs through recombinant DNA technology. V40C2, a specific ELP, can be fused to BMP-2 and purified through inverse transition cycling to create a BMP-2-V40C2 fusion protein. Incubation of C2C12 cells for seven days in the presence of 1 mg/mL of this BMP-2-V40C2 fusion protein has indicated that the protein still retains its bioactivity while now possessing the ability to aggregate at normal body temperatures.
Nanoparticles for Lung Gene Therapy

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Keywords: Elastin like peptides, gene therapy.

Chronic Lower Respiratory Diseases (CLRD) including chronic obstructive pulmonary disease (COPD) and cystic fibrosis (CF) are characterized by the degradation in the elasticity of the alveoli and increased in collagen. The result is a decrease in gas exchange rate and an increase in the inflammation rate. Overall, these diseases can result in poor breathing efficiency that can be fatal.

In this work, we propose the development of nanoparticles that can be used as a delivery system that can incorporate a gene knock-in (eg. cystic fibrosis transmembrane regulator (CFTR)) or gene knock-out (eg. pro-inflammatory inhibitor) to repair the elasticity of the alveoli. The nanoparticles will consist of elastin like polypeptides (ELPs) fused with low density lipoprotein receptor repeat 3, LDLR3. ELPs are stimulus response polymers that are biodegradable, biocompatible, and have high tunability. They contain a repeated sequence of the pentapeptides VPGXG where X can be any amino acids except for proline. The low density lipoprotein receptor (LDLR) is a cell-surface glycoprotein that is critical for the homeostasis of the cholesterol in the body. LDLR3, a part of the LDLR, is found to bind with vesicular stomatitis virus glycoprotein G (VSV-G) envelope in the presence of calcium. Using restriction enzymes, our results have shown that fusion protein, ELP-LDLR3, was synthesized. These nanoparticles hold promise for restoring the repair process of the lung focusing on the alveoli cell functions.
Fabrication of a Combinatorial High Throughput Soft Biomaterial to Screen Cell Mechanotransduction

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Keywords: biomaterials, tissue engineering, combinatorial methods, cell adhesion, mechanotransduction.

Combinatorial biomaterials that encompass a wide range of mechanical and biochemical properties have the potential to offer a comprehensive understanding of complex cell-substrate interactions. An added advantage includes rapid screening of multiple variables that accelerates the pace at which this knowledge is attained. This has a direct impact on the evolution of functional biomaterials for tissue engineering applications. The long term objective is to fabricate biomaterials with optimized design parameters that precisely control cell adhesive interactions to direct cell fate.

A cross-linked network of polydimethylsiloxane (PDMS), a silicone polymer, is used as a model material since both its mechanical and chemical properties can be modulated independently to develop novel gradient materials. Presented here is the fabrication of a combinatorial biomaterial that has a mechanical gradient along one axis and a surface chemistry gradient that is perpendicular to the mechanical gradient. The experimental set up for manufacture of mechanical gradient included a programmed dual pump system with one containing a “low modulus” PDMS mixture and the other a “high modulus” PDMS composition, a static mixer and a moving stage to collect the dispensed gradient polymeric mixture. The polymeric gradient mixture was then cured in the oven overnight at 65°C for curing. The mechanical gradient has a high elastic modulus (~1.5 MPa) at one end that transitions to a low elastic modulus (0.02 MPa) at the other end. The surface chemistry gradient was then superimposed atop and perpendicular to the mechanical gradient. The surface gradient was obtained through a spatiotemporally regulated Ultraviolet-Ozone-Oxidation (UVO) of the silane monolayer on the polymer which causes the exposure dependent transition from hydrophobic (~100°) to hydrophilic (~<15°) over the length of the sample. Water contact angle characterization of the substrates confirmed the formation of a continuous gradient in surface chemistry.

Cell response to a surface chemistry gradient generated on PDMS was investigated using NIH3T3 fibroblast cells seeded on gradient substrates following sterilization and coating with fibronectin, an adhesive protein. These experiments indicated a strong dependence of cell adhesion and spreading on the hydrophobicity of soft substrates along with a strong influence of fibronectin adsorption and conformation on cell response. Future experiments involve utilizing the combinatorial biomaterial described above to screen cell-cell and cell interfacial interactions to identify trends and patterns in cell behavior.
Effect of Viscosity on Opuntia ficus-indica Fiber Formation

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Keywords: Opuntia ficus-indica, electrospinning, nanofibers.

Electrospinning is a process in which the surface tension of a polymer solution is influenced by an electric field and then undergoes plastic stretching to form fibers. A polymer cone forms at the tip of a needle and a jet of fibers are collected on a collector plate as a non-woven web. The nanofibers are collected in spiral manner with diameters ranging from nanometers to a few microns. Parameters, which may affect the formation of fibers, are the infusion rate, applied voltage, temperature, and/or distance to the collector, etc. Although there are many operational and material parameters that affect the fiber formation, it has been noted that viscosity has a significant affect when compared to the others. The change in the concentration of the solution changes its viscosity measurements. It is suggested that this change in viscosity will impact the formation of fibers and the reduction of bead formation.

This paper mainly focuses on tracking concentration versus viscosity and its effect on fiber formation. Different polymer solutions of natural materials and dopants show changes in viscosity and successful fiber formation. The natural material, cactus mucilage from the \textit{Opuntia ficus-indica}, is mixed with a polymer solution called polystyrene and a solvent, D-limonene, in different volume ratios of 70:30, 50:50, 30:70. For low concentrations of cactus mucilage:polymer to solvent, fiber formation is low and the solution electrosprays. For higher concentrations, electrospun nanofibers are formed and a fiber membrane is fabricated. Viscosity measurements are collected and mapped to concentration and fiber formation. This cactus nanofiber membrane is used as a water filter to demonstrate functionality of removing arsenic content from water. Atomic Fluorescence Spectrometry (AFS) tests are performed using polystyrene and D-limonene: mucilage nanofibers and results show removal of up to 18.94% of arsenic.
A new oversampling method for imbalanced dataset classification of Pelvic Organ Prolapse

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Keywords: imbalanced dataset, classification, Pelvic Organ Prolapse, Support Vector Machines

Pelvic Organ Prolapse (POP) is a major health problem that affects up to 30-50% of women. It is a herniation of the female pelvic floor organs (bladder, uterus, small bowel and rectum) into the vagina. This condition can cause significant problems including a bothersome vaginal bulge, incomplete bowel and bladder emptying. Although clinical examination is currently used to diagnose POP, there is still little evidence on specific risk factors that are directly related to particular types of POP and their severity or stages. Current studies mainly focus on univariate models in which one single feature (variable) is used at a time and rarely consider multivariate models. Moreover, clinical datasets such as those for POP are commonly highly imbalanced, where the majority of the data represents one or few classes. The class imbalance problem is a big challenge in classification problems and can significantly weaken the performance of classifiers.

In this work, we present a new oversampling method called Adaptive Cluster-based Borderline Oversampling (A-CBOS) for imbalanced dataset classification and analyze its performance for the binary classification of POP. A-CBOS clusters the minority and majority instances separately and determines adaptively the size of each cluster for oversampling. Then, the minority instances are oversampled depending on their distance to the majority class while the majority instances are oversampled using conventional oversampling techniques. A-CBOS is adaptive, avoids generating instances that overlap among different classes, and does not ignore small or isolated clusters.

The proposed method was tested on a dataset of 207 patients containing information on background, clinical history, and magnetic resonance imaging (MRI) measurements. A-CBOS was compared with five other balancing methods and tested using a Support Vector Machines (SVM) classification model to classify cases into high-stage prolapse and low-stage prolapse. The performance measures used to compare the different methods are: F-measure, G-means, and Area under Receiving Operator Characteristics Graph (AUC). Our results indicate that A-CBOS performs the best among all other balancing methods. The overall performance of our model was also compared with the three most widely used POP assessing methods. Results show that our method achieves higher accuracy in classifying POP cases and provides sets of risk factors for the different types of prolapse.
Stress-Limiting Test Structures for Rapid Low Cost Strength Assessment

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Keywords: 3D printing, Additive Manufacturing, solid freeform fabrication, materials testing, low cost testing

This project designed and manufactured a planar structure, which under force undergoes a defined displacement. The structure has a series of thin members which bend around circular cams of different radii. The Bernoulli-Euler hypothesis states that the moment and hence the stresses are proportional to the curvature. Thus the varying size of the cams puts varying strains on the members. The cam which causes the members to fail indicates the strength of the material. Successfully completing a displacement demonstrates a minimum strain capability of the sample. A series of test coupons can be used to bound the strength of the printed components without requiring expensive testing equipment. The vibration frequency of the test structure also provides a measure of the part stiffness and can provide a non-destructive measurement of process consistency. This approach could be a useful process characterization/monitoring method for additive manufacturing systems. This planar structure was used to investigate variations between thermal extrusion parts on the same machine and between different machines.
Study of Piezoelectric effect from ZnO nanowires grown on curved substrates

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Keywords: Piezoelectric effect, ZnO nanowires, Flexible electronics, Energy Harvesting devices

ZnO nanowires grown on a flexible electrode have been shown to display piezoelectric properties that could have a significant impact in energy harvesting applications, sensors, actuators, as well as several other applications. These ZnO NWs exhibit piezoelectric effect when the flexible substrate on which it has been grown is subjected to mechanical strain. While this piezoelectric effect has been previously studied on ZnO NWs grown on flat surfaces, this work aims to characterize the differences between ZnO NWs grown on curved and flat substrates in terms of both structural and piezoelectric properties. Piezoelectric properties will be tested using an electrochemical cell with an electrochemically active redox material. This specific test has distinct advantage over traditional techniques especially for ZnO nanowires grown on curved substrates. Significant structural differences have been observed in SEM images comparing ZnO NWs grown on a curved surface with ZnO NWs grown on a flat surface. Due to these significant structural differences it is expected that the ZnO NWs grown on a curved surface will exhibit different piezoelectric properties.

Figure 1. SEM Image of ZnO NWs grown on curved substrate.

Figure 2. SEM Image of ZnO NWs grown on flat substrate.
Design of a Novel Gas-Phase Bench-Scale Photocatalytic Reactor for CO2 Conversion

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Keywords: Photocatalysis, Reactor design, Bench-scale reactor

When characterizing the performance of a photocatalyst, it is important to understand the effect that reaction parameters such as temperature, flow rate, catalyst loading, and light intensity have on the overall activity of the photocatalyst. By performing experiments in a reactor and monitoring the concentration of products over time, the rate of reaction can be determined in order to describe the activity of the photocatalyst. This poster presents a novel design approach for a gas-phase bench-scale photocatalytic reactor intended for characterizing a wide range of photocatalysts. The design was created in SolidWorks 2013, and then machined out of 316 stainless steel. A threaded light mount allows an LED light source to be easily mounted to the reactor to shine light through a quartz window and onto the sample. An integrated heating element that uses nichrome resistive heating wires is mounted to the bottom of the reactor. The nichrome wires are aligned in an arrangement that allows uniform heating. To monitor the temperature of the catalyst, a k-type thermocouple was introduced through the side of the reactor underneath the catalyst bed, which is a porous quartz frit. The quartz frit has high surface area to increase the overall conversion. These design features of this reactor are unique and give the potential to produce groundbreaking discoveries in the field of photocatalysis.
In Vacuo Study of the Electronic Structure of Atomic Layer Deposition prepared Ru/RuOx Thin Films on Au by means of Photoemission Spectroscopy and X-Ray Diffraction

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Keywords: ALD, Au, Ru, RuO\textsubscript{2}, electronic structure, XPS, UPS, IPES, in vacuo, XRD

The electronic structure of a contamination free gold-ruthenium(oxide) interface (Au-RuO\textsubscript{x}) was investigated with the goal of establishing a relationship between ALD precursor respectively reactant injection time and the formation of thin films with different oxidation states accompanied by changes in work function, interface dipole and distinctness of core level, valence band and conduction band features. Therefore, a series of ruthenium (Ru\textsuperscript{0}) and ruthenium oxide (RuO\textsubscript{x}) thin films were prepared on top of 100 nm polycrystalline gold (Au) substrates using atomic layer deposition (ALD) with the precursor gas bis(ethylcyclopentadienyl)ruthenium(II) (Ru(EtCp)\textsubscript{2}) and oxygen (O\textsubscript{2}) as reactant. The interfaces were studied using photoemission spectroscopy in conjunction with X-Ray diffraction (XRD). In the interest of preventing exposure to the ambient throughout this study and to generate more accurate results, a homebuilt, high vacuum capable ALD reactor attached to an ultrahigh vacuum analysis chamber was used which allowed transfer and subsequent photoemission study of samples completely \textit{in vacuo}. We could show that the injection rates of precursor gas and reactant have a direct influence in the formation of a ruthenium(oxide) layer and an associated interface dipole allowing for a tailor design of sub 100 nm conductive thin films with varying work functions. Partial removal of material in a sputter and photoemission analysis sequence revealed the homogeneity and the chemical structure of the thin film overlayer. XRD was used to calculate thickness and oxidation state of investigated samples.
Potential Impact of H7N9 Influenza Virus Pandemic Outbreak in the U.S.

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Keywords: Pandemic, Simulation, H7N9, Non-Pharmaceutical Interventions

Until October 2nd, 2014, WHO reported 453 confirmed cases (with fatality around 38%) of H7N9 virus in China. Current concerns are that H7N9 might become human-to-human transmittable and spread internationally. To address this issue we use data from recent reports and a simulation model to predict the potential impact of H7N9 pandemic in the U.S. This impact is evaluated through an Agent-based simulation model by using Non-Pharmaceutical Interventions (e.g. antivirals, school closures, etc.).
Open Source Ion Trajectory Simulation with OpenFOAM

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Keywords: ion optics, OpenFOAM, SIMION, numerical simulation

Devices that rely on ion optics in vacuum systems have become commonplace in both the scientific and medical realms. Such devices include mass spectrometers, ion mobility spectrometers, focused ion beams, etc. Prediction of the applied signals required to operate these devices and the trajectories of the ions introduced into the resulting fields is crucial for the development of novel, functional devices. Using the open source finite volume method C++ library package, OpenFOAM, a series of solvers has been developed to calculate both the electric fields within a domain as well as the resulting ion trajectories of simulated particles. These solvers were validated against the industry leading ion trajectory simulation software, SIMION. Two test cases have been assessed, a single Einzel lens device and a three Einzel lens device with an intermediate aperture. In both test cases the trajectories calculated by the OpenFOAM solvers closely matched those calculated with SIMION. In light of these results, OpenFOAM can be considered a viable open source option for calculating electric fields and ion trajectories.
Systems and Methods for Detecting the Presence of a Lead Contaminant

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\textbf{Keywords:} Lead; Lead detection; Infrared; FTIR; Nanoparticle

Lead is used in various industrial manufacturing sectors, such as lead-acid batteries, welding rods, paints and glazes. The most common applications are to produce lead-acid batteries and reprocess the lead from lead wastes. The larger amount of workers are exposed to lead contaminant similar to lead processing industries. Currently, lead detection technology used in industry is Colorimetric Screening Method. Color changing is observed when lead contaminant is present. However, this technique has serious drawbacks in sensitivity and reliability which is also not specific due to coloration with several common cations.

Our research concentrates on developing a system and method for detecting the presence of lead contaminants. Our method of lead detection allows the infrared signal to reflect from uneven surface (generally not reflecting surface) with the use of nanomaterials. The infrared signal of the lead contaminants (lead oxide and lead sulfide etc.) were reflected from the chicken skin containing our propriety nano-materials. The infrared signals (peaks) of lead contaminant present from 700 -400 cm\(^{-1}\) were exploited to understand the lead present in the skin. The work is in progress to include quantitative analysis and parameters optimization.
Intragap States-Induced Catalytic Activity of TiO$_2$ under Visible Light: En Route to Solar Fuel Production

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**Keywords:** Oxygen Vacancy; Intragap States; Photoreduction; TiO$_2$; Photocatalyst

CO$_2$ is the major greenhouse gas emitted through humankind activities. Forests and non-agricultural land act as a natural sink for CO$_2$ removal from the atmosphere. Nevertheless, the amount of emitted CO$_2$ is significantly larger than the capacity of these natural sinks. This leads to global warming and malignant impacts on human body. One of the means to decrease the amount of generated CO$_2$ is to end using fossil fuels. However, coal-fired power plants remain to be the largest source of electricity generation in 2014. Electricity generation and transportation hold the largest share in green-house gas (such as CO$_2$) emission. Hence, new systems and strategies are crucial to remove CO$_2$. In this work, we are presenting novel TiO$_2$ nanoparticles, synthesized via a facile solution-phase method, which show a significant visible light absorption and catalytic property toward photoreduction of CO$_2$ to CO and CH$_4$. A thorough photoemission spectroscopy analysis outlined the energy structure of the materials which shows a sub-bandgap absorption in visible range due to the presence of intragap states. The origin of intragap states was investigated in a greater detail using various characterization techniques. An in-depth chemical composition study of the developed material using X-ray diffraction (XRD), X-ray photoelectron spectroscopy (XPS), and inductively coupled plasma mass spectrometry (ICP-MS) indicated that the synthesized material is considerably un-doped. Further structural study using transmission electron microscopy (TEM) showed that distances between visible lattice fringes are matched with ordered crystalline phases of TiO$_2$. The core emission study using XPS revealed that the oxygen vacancy defects in the structure--i.e. likely due the synthesis--are responsible for intragap states formation. The gas-phase photoreduction results (toward production of solar fuels) show comparable efficiency to that of doped and/or treated structures. This study offers a novel inexpensive material and method for photoreduction of CO$_2$ and generation of solar fuels.
ELP-Cell Interaction through Sequence Modulation for Treatment of Chronic Wounds

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Keywords: Chronic wounds, Elastin like peptides, Fibroblasts proliferation

Chronic wounds affect 5.7 million patients and cost an estimated 20 billion dollars annually. Recently, we developed a growth factor delivery platform based on elastin like peptides (ELPs) for growth factor delivery to chronic wounds. Elastin like peptides are repeats of the pentapeptide (VPGXG, X=guest residue can be anything but Proline) derived from natural elastin. They are attractive delivery vehicles due to their unique phase transition properties and are genetically encodable and biocompatible. Compare to their physical properties, their biological activities on tissue regeneration are still poorly understood. In this study, we created several ELP sequences and for the first time, we looked into ELP bioactivity on fibroblasts proliferation and function and the mechanism behind the phenomena. Our data strongly suggests that ELP may be beneficial for chronic wound healing not only as drug delivery vehicles but also through their intrinsic biological activities.

In our previous study, we observed that elastin like peptides increased granulation tissue formation of diabetic mice wound model. We proposed that ELPs might have a positive effect on fibroblast proliferation and function. The data of our first series of experiments indicated that ELPs induce human skin fibroblasts proliferation in a dose dependent manner (Figure 1). Moreover, the ELPs induced proliferation was successfully blocked using surfen, which is a small molecule antagonist of heparan sulfate suggesting that ELPs bind to cell surface heparin sulfate proteoglycans to induce proliferation. Interestingly, after we immobilized ELP monomers, their biological effect on fibroblasts disappeared suggesting that the transition behavior is crucial to their bioactivities.

Our study suggests that ELPs induce fibroblast proliferation in a dose dependent manner. Furthermore, our data suggest that ELPs induce their biological effect on fibroblasts through interaction with the heparan sulfate presenting on the fibroblast surface. We also have data indicating that PKC pathway is responsible for this ELP induced proliferation. An understanding of the exact interaction of ELPs and identifying the determinants of this interaction (i.e. transition behavior, charge of guest residue) will help us in the design of unique ELP based biomaterials having the desired physical and biological properties that are conducive to the healing of chronic wounds. Thus they will not only be useful as drug delivery vehicles but also may induce healing synergistically through their intrinsic biological activities.
Ambient Assisted Living Technology Assessment and Validation for the *AlwaysNear* Sensor Based, In-Home Monitoring of Senior Health

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**Keywords:** Ambient Assisted Living, Smart Home, aging in place

Ninety one percent of seniors live in individual residences under the care of family caregivers without requisite monitoring of their daily activities. The number of seniors whose daily activities need monitoring will grow as our nation ages and the life expectancy of individuals increases.

*AlwaysNear* provides a wireless sensor system solution to comprehensive 24/7 monitoring of the daily living activities of seniors living in an individual residence. The sensory system issues alerts when deviations from the daily living activities are detected. The alerts are responded in a number of different ways from calling the individual all the way up to deployment of emergency responders depending on the escalation of the alert.

The goal of this project is to validate the *AlwaysNear* home monitoring sensory system functionality, evaluate the alert response system’s performance, and lay the groundwork for an extended health outcomes study.

Through a multi-phase approach, first a study of existing assisted living technologies and research groups in similar areas is performed to identify current methods, potential constraints, and future opportunities. Second, the sensors are tested for functionality at the *St. Joseph’s John Knox Village* “Living Lab” using a comprehensive list of validation parameters. Finally, the alert response system is verified and, through studying physical changes and behaviors of late life, additional alert conditions are established to improve detection of adverse events.

Plans for the second phase include large-scale data collection and prediction of adverse health outcomes. In early 2015, recruiting of older adults will begin within *The Villages* retirement community. The *AlwaysNear* response system will be exhaustively tested in 60 homes of older adults with a variety of health conditions. Data will be collected to benchmark predictive models for detecting health decline and adverse events as they occur. Health outcomes of older adults are expected to substantially improve through incorporating ambient assisted living technologies that provide a safe option to aging in place.
Research Category # 3: Sensing, Networking, Communications, Computing, Biometrics and Pattern Recognition
Advanced cybersecurity methods for network intrusion detection

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Keywords: Bagging, Boosting, Stacking, Intrusion detection, Computer networks

The goal of this work is the investigation of the application of ensemble learning techniques to the intrusion detection process in computer networks. Different types of ensemble learning techniques such as boosting and bagging and stacking are tested using a data set provided by DARPA. This data set has 41 features that are believed to detect malicious activities in computer networks. The research is primarily focused on highly challenged networks. Such networks may be characterized by intermittent connectivity, a heterogeneous mix of nodes, nodal churn, high mobility, and widely varying network conditions. Examples of challenged networks include inter-planetary networks, sensor and wildlife monitoring networks, underwater networks, rural and remote areas, and military battlefields.
Energy-Aware Database Disk Storage System

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Keywords: Database management system (DBMS), Dynamic power management (DPM), Energy-aware storage, Performance guarantee

Energy consumption has become a first-class optimization goal in the design and implementation of computing systems. The database management system (DBMS) is the major consumer of energy in modern data centers. Therefore, we propose our recent research on designing the power-aware database storage system. The dynamic power management (DPM) techniques are the most efficient and common methods used to save energy in disks. They decide in real-time when to transition the disks to lower power mode while experiencing long idle periods. In this work, we introduce our DPM model to be integrated into the DBMS’s data management engine in order to minimize the power consumption of the database disk storage system while satisfying the given performance bound. It dynamically determines the optimal disks speed configuration based on the disks predicted workloads and response time threshold and performs the corresponded data migration among disks. Also, we have proposed the heuristic algorithm for determining the optimal disk state configuration with its complexity proof. We evaluated our proposed ideas by running experimental simulations using several synthetic workloads. Our experimental platform consists of the widely used disk simulator named Disksim interacting with our DPM model server. We enhanced Disksim with extra features to support the DPM model. Our results clearly show promising energy savings with small response time penalty. It provided more energy savings compared to the work done in “Dynamic Data Reorganization for Energy Savings in Disk Storage Systems” paper.
Reduce impact force in landing phase of jumping process for humanoid robots

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Keywords: Humanoid Robot, Robot Control, Jumping Process, Compliance motor

This research has been conducted with the aim of developing a control system to reduce force impact in the landing phase of a jump process for a humanoid robot.

Our humanoid robot uses DC motors with compliance capability. In the landing phase, the compliance capability is enabled for the motors in knee and ankle joints. A robot model with three degrees of freedom was implemented. This model consists of the ankle, knee and hip joints of a complete humanoid robot.

This process allows the reduction of impact force for knee and ankle motors, but at the same time it is causing an unstable robot landing and the robot falls down. In order to reduce the instability in the robot, it is necessary to design a control system to guarantee the stability of the landing phase.

A basic robot was developed to perform different control algorithms and reduce the force impact in the lower joints. In this poster, the basic robot, control system, and landing process are displayed.
Image Segmentation Using Evolutionary Game Theory

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**Keywords:** image segmentation, evolutionary game theory, graph theory, quadratic optimization problem.

The problem of image segmentation is an important challenge for the computer vision community. Segmented images are needed for a wide range of computer vision problems such as object recognition, image matching, figure-ground separation, etc. There exist many methods for image segmentation with applications in many areas.

Recently applications of evolutionary game theoretic methods based on standard quadratic programming have been shown for image segmentation. The image to be segmented is represented as an edge-weighted undirected graph, where vertices correspond to individual pixels and the edge-weights reflect the “similarity” between pairs of vertices. Since in these methods, the similarities between every pair of pixels is needed, when the size of the image becomes large, the space complexity could be intractable. We present an efficient approach for image segmentation using evolutionary game theory which overcomes the space complexity problem. We propose a grid based approach that divides an image into disjoint subsets of pixels, and the clusters obtained representing different segments of each grid are grouped using a low resolution ensemble clustering method. In other words, the exact maxima of the corresponding quadratic programming problem are approximated by the exact maxima of all grids. Then, pixels are assigned to the final segments using a game theoretic relation.
Non-contact measurement of electrical conductivity of printed conductive traces using microwave microscopy

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Keywords: Direct print additive manufacturing, electrical conductivity, imaging, non-contact scanning microwave microscopy, topography, printed electronics.

Electrical conductivity is a critical parameter for the design of microwave devices and systems. For conductive printed traces, electrical conductivity is influenced by the ink type and the thermal curing process in that a reduction of the curing temperature results in a reduction of the final conductivity of the silver ink. Typical techniques used to measure electrical resistivity (1/conductivity) of printed traces include: four-point probe technique and extraction from electrical resistivity definition ($\rho=RA/l$), where R is the electrical resistance which can be measured using a multimeter, and A and l are the trace dimensions and can be measured using a stylus profiler or scanning electron microscope (SEM). The four-point probe technique and electrical resistivity equation provide an averaged value of the electrical resistivity and do not show localized variations of the resistivity over the sample’s surface, which can affect the performance of the printed structures, particularly for high frequency applications. Another relevant aspect of these approaches is that the measurement is performed at DC, not being able to characterize the conductor at microwave frequencies.

In this poster non-contact measurement of electrical conductivity of direct digital manufactured traces using a dielectric resonator-based near-field microwave microscope (NFMM) operating at 5.73 GHz is presented. The NFMM uses a set of printed samples with known conductivity to build a calibration data set which correlates measured quality factor (Q) data with electrical conductivity ($\sigma$). Direct print additive manufacturing is used to produce the 10 mm x 10 mm calibration samples using CB028 silver ink and glass as the substrate. Conductivity of calibration samples ranges from 1.70e6 S/m to 3.22e6 S/m and it is measured using a commercially available four-point probe. Conductivity measurement of the calibration samples using NFMM reveals that the microscope is sensitive to printed samples with different conductivities and that it is able to resolve differences in conductivities as small as 0.38e6 S/m in the range 2.20e6 S/m $\leq \sigma \leq$2.53e6 S/m. Conductivity and topography images of a printed trace are acquired simultaneously over a scan area of 100 $\mu$m x 100 $\mu$m using the non-contact NFMM at a distance of 3 $\mu$m from the sample. Conductivity images reveal that the conductivity is not constant over the scan area and that it varies from 0.6 S/m to 2 S/m. Roughness calculated from NFMM topography shows good agreement with the values computed from profilometer data.
**Inertia Based Recognition of Daily Activities and Falls**

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**Keywords:** machine learning, wireless sensors, accelerometer, inertia, fall detection

The population of the United States is aging. Based on the latest predictions by the Administration of Aging (AoA), under the United States Department of Health & Human Sciences (USDHHS), by 2020 there will be approximately 55 million people in the US aged 65 or older, which is almost double its value in 1990 [http://www.aoa.gov/Aging_Statistics/future_growth/future_growth.aspx#age]. This growth is exponential, as in 2050 there will be 90 million people aged 65 and older. An aging population brings with it a wide scope of healthcare problems, some of which are more wide spread and require immediate attention. The US Center for Disease Control (CDC) has created a website to review statistics and risks associated with falls among older adults in our population [http://www.cdc.gov/homeandrecreationalSafety/falls/adultfalls.html]. Some of the studies in the literature have both surprising and frightening findings, such as the one by CDC in August of 2013, which found out that among older adults, falls are the leading cause of both fatal and non-fatal injuries [http://www.cdc.gov/injury/wisqars/]. The economic costs are also staggering, as in 2010, the direct medical costs of falls was $30 billion. These findings represent an even bigger challenge for our state of Florida, which currently ranks #1 among all 50 states in terms of the percentage of people over 65 years of age. Based on US Census Bureau, 18.2% of Florida’s population was 65 or older which represents approximately 3.5 million people [http://www.aoa.gov/Aging_Statistics/Profile/2013/8.aspx].

The main objective of our research is to develop a classification algorithm to detect and report falls in elderly people by analyzing real data generated by industry standard 3-axis accelerometers embedded on digital wireless wristbands used in healthcare facilities. To accomplish this goal we have looked at two different applications: 1) detection of falls and 2) recognition of human behavior on a defined set of motions to ultimately create a better predictor for fall possibility. We created a compact feature set consisting of average acceleration values on each of the 3-axis’, the ratio of the highest and lowest average acceleration values and the average number of times the acceleration values exceed the nominal value of 1G. We have tested the feature set on two expert models: 1) RBF–based support vector machines and 2) feed–forward neural networks. We have used the publicly available wrist-worn accelerometer dataset from University of California Irvine’s machine learning repository [https://archive.ics.uci.edu/ml/datasets/Dataset+for+ADL+Recognition+with+Wrist-worn+Accelerometer] and compared our results with the latest literature published using the same dataset [Bruno et. al. 2013. Analysis of Human Behavior Recognition Algorithms based on Acceleration Data]. Our initial findings show 100% accuracy on the detection of fall data including both true positives and true negatives using a limited dataset. We also achieved a significantly better average accuracy (87% vs. 68%) for automatic behavior recognition on a set of 7 different motions when compared to previous algorithms in the literature.
Pattern Theory-Based Representation and Interpretation of Activities

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Keywords: activity recognition; pattern theory; graphical methods; compositional approach

In this poster, we present a combinatorial approach to identifying interactions in videos using concepts from Grenander’s pattern theory. The basic units of representations, termed generators, are linked with each other using pairwise connections, termed bonds, that satisfy predefined relations. Different generators are specified for different levels, from features at the bottom level to actions at the highest, providing a rich representation of items in a scene. The resulting configurations of connected generators provide scene interpretations; the inference goal is to parse a given video data and generate high-probability configurations. The probabilistic structures are imposed using energies that have contributions from both data (detector scores) and prior information (ontological constraints, co-occurrence frequencies, etc). The search for optimal configurations is based on an MCMC, simulated-annealing algorithm that uses simple moves to propose configuration changes and to accept/reject them according to the posterior energy. In contrast to current graphical methods, this framework does not preselect a neighborhood structure but tries to infer it from the data. This framework can potentially handle clutter, i.e. objects/actions that are not related to the main activity, and can infer actions despite some unobserved components. It is demonstrated and evaluated using video snippets from the YouCook dataset, and is shown to have a good performance, an overall recall and precision improvement of more than 50% and 100%, respectively.
Physical-Statistical Modeling of Cardiovascular Systems for Optimizing Medical Decision Making

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Keywords: sodium channel, cardiac myocytes, simulation model, design of computer experiments, Gaussian process, statistical metamodel

Glycan structures account for up to 35% of the mass of cardiac sodium (Nav) channels. To question whether and how reduced sialylation affects Nav activity and cardiac electrical signaling, we conducted a series of in-vitro experiments. Although aberrant electrical signaling is observed in reduced sialylation, realizing a better understanding of mechanistic details of pathological variations in I_Na and AP is difficult without performing in-silico studies. However, computer model of Nav channels and cardiac myocytes involves greater levels of complexity, e.g., high-dimensional parameter space, nonlinear and non-convex equations. Traditional linear and nonlinear optimization methods have encountered many difficulties for model calibration. This research presents a new statistical metamodeling approach for efficient computer experiments and optimization of Nav models. First, we utilize a fractional factorial design to identify control variables from the large set of model parameters, thereby reducing the dimensionality of parametric space. Further, we develop the Gaussian Process (GP) model as a surrogate of expensive and time-consuming computer models and then identify the next best design point that yields the maximal probability of improvement. This process iterates until convergence, and the performance is evaluated and validated with real-world experimental data. Experimental results demonstrated the efficiency and effectiveness of the presented algorithms, especially for large-scale simulation models that are computationally expensive and time consuming. This study improves the understanding of glycosylation-associated pathology of cardiac disease, and potentially contributes to the development of pertinent therapeutic solutions.
In Vivo Wireless Communications - Channel Modeling

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Keywords: Body area networks, channel model, in vivo propagation, medical implants, security

Accurate channel models are important when designing in vivo wireless biomedical devices that do not harm biological systems and to optimize communication systems. Although on-body wireless communication channel models are well studied, there is much less work for in body (in vivo) channels. In vivo channel characteristics are quite different than the classical communication channel due to electromagnetic wave propagation through biological tissues that have different electrical properties. Analytical modeling is very challenging and usually the in vivo channel is studied with using software models and tools. In our investigation, we used High Frequency Structural Simulator (HFSS) and its human body model, which includes over 300 parts (bones, muscles, organs, etc.) with appropriate frequency dependent dielectric properties.

Location dependent characteristics of the in vivo wireless communication channel are investigated in this simulator environment. A dipole antenna may be placed inside the body and another in both near and far field regions. It is well known that near and far fields are not directly related due to presence of reactive fields in the near field. Path loss information is obtained through the transfer function S21, and significant angular dependence of the wave attenuation is observed. These initial results show us the importance of accurate channel models for in vivo communication.

In order to investigate the path loss without antenna effects, we also calculate the path loss by using the electric field radiated by a Hertzian-Dipole located inside the abdominal cavity. The simulations quantify and confirm that the path loss falls more rapidly inside the body than outside the body. A small range of fluctuation is observed, which shows that the human body is only mildly inhomogeneous and, consequently, that the path loss is slightly angular dependent. In comparison with the path loss measured with monopole antennas, we conclude that the significant variations in Received Signal Strength are caused by both the angular dependent path loss and the significantly modified in vivo antenna effects.

Another important aspect of this research that should be taken into consideration is security of wireless implantable medical devices (IMDs). Securing IMDs against malicious attacks emerges as one of the most critical issues in deploying these devices as any weakness may lead to serious problems, such as theft of private medical information, wrong treatment and even death. Many studies addressing various IMD security issues are presented in the literature. Most of these studies are based on cryptography. However, physical layer approaches are also needed to empower the security in lower layers. Since physical layer security approaches mostly utilize the characteristic features of the wireless channel, a good understanding of the channel inside and around the body is crucial for introducing new techniques and observing their performance in a simulation environment.
Prediction of Treatment Outcome in Soft Tissue Sarcoma Based on Radiologically Defined Habitats

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Keywords Soft Tissue Sarcomas, Intensity Histograms, Segmentation, Metastasis, Necrosis, Meta-classifiers

Soft tissue sarcomas are malignant tumors which develop from tissues like fat, muscle, nerves, fibrous tissue or blood vessels. They are challenging to physicians because of their relative infrequency and diverse outcomes, which has hindered development of new therapeutic agents. Additionally, assessing imaging response of these tumors to therapy is also difficult because of their heterogeneous appearance on magnetic resonance imaging (MRI). In this paper, we assessed standard of care MRI sequences performed before and after treatment using 36 patients with soft tissue sarcoma. Tumor tissue was identified by manually drawing a mask on contrast enhanced images. The Otsu segmentation method was applied to segment tumor tissue into low and high signal intensity regions on both T1 post-contrast and T2 non-contrast images. This resulted in four distinctive sub-regions or “habitats.” The features used to predict metastatic tumors and necrosis included the ratio of habitat size to whole tumor size and components of 2D intensity histograms. Individual cases were correctly classified as metastatic or non-metastatic disease with 83.33% accuracy and for necrosis ≥ 90 or necrosis < 90 with 73.07% accuracy by using meta-classifiers which contained feature selectors and classifiers.
Control and Coordination of a Team of Differential and Omni Drive Autonomous Robots for the Robocup SSL

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Keywords: Multi-Robot, Autonomous, Soccer, Artificial Intelligence, Closed Loop Control, Differential Steering, Omni-Directional, Path Planning

This research was conducted with the aim of developing a hierarchical control scheme and a fast obstacle avoidance algorithm for a team of autonomous robots to compete in the Small Sized League of the Robot Soccer World Cup in 2015.

Our hierarchical control structure and obstacle avoidance algorithms were implemented in C++ and tested on an open source robot soccer simulator, grSim. Successful implementations in the simulator were transferred to a team of real robots using the standard SSL vision system and referee box.

The transfer to real differential-drive robots required several refinements to the differential-drive motion control algorithms to account for steady state errors and to decouple translation from rotation at the destination. Refinements to the omni-directional motion algorithms were also made to allow for translation while facing an arbitrary point.

A GUI showing real-time information about the robot positions was created to track the progress of the path planning algorithm.

In this poster, the refinements to the motion control algorithms, the latest control structure, and the path planning methods are displayed.
A Microwave Radiometer Used for the Measurement of the Absolute Subsurface Temperatures of Pressure Sores

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Keywords: Radiometric measurements, temperature, pressure sores

This research supports efforts to establish the presented subsurface temperature (radiometric) measurement system as a replacement to the subjective pressure sore assessment methods that rely chiefly on visual inspection and to help move forward the modern, yet limited, preventative methods in place to avoid pressure sore formation. While pressure sores are preventable during their earlier stages, there exists a deficiency in the currently prescribed detection methods (visual inspection). Improved knowledge on the long-term monitoring of pressure sores for hospitalized patients will result in enhanced clinical outcomes and reduced healthcare costs for the elderly and chronically ill. Our system uses a microwave radiometer to non-invasively, wirelessly, and accurately measure thermal emissions originating at a certain distance within the human body. These thermal emissions are modeled for the human body, taking into account the influences of the antenna and the monitoring device, to resolve the actual subsurface temperature. To date, the antenna and radiometer system is limited to a bench top assembly. This work will enable the creation of a portable radiometer and a contacting antenna that will in turn move forward the scientific knowledge on the objective monitoring of sub-skin human body temperatures.
3-D Electrically Small Half-Wave Dipole

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Key words — 3-D antenna; Dipole; GCPW balun; 6 GHz

In this work, a 3-D electrically small half-wave dipole antenna is presented. The design consists of a 50 ohm feeding transmission line (TL) connected to a grounded coplanar wave guide (GCPW) balun that provides a transition from unbalanced TL to balanced TL, which is suitable for feeding the dipole. The antenna will be fabricated using Direct Digital Manufacturing (DDM) technique for the fabrication of circuits and devices. The antenna is designed in such a way it has been shielded from bottom using a ground plane to meet the requirement of some applications such as mounting the antenna over a vehicle. The design is accomplished using ABS substrate with 2.7 permittivity and 0.008 dielectric loss tangent at a design frequency of 6.0 GHz, where the antenna offers a physical size of 22 mm × 16.5 mm. The simulation has been carried out using the FEM-based full-wave simulator HFSS, where the antenna show very good matching at the design frequency (-30 dB return loss) and a gain of 6.1 dB.
Predicting Outcomes of Non-Small Cell Lung Cancer Using CT Image Features

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Keywords: Computed tomography, CT 3D texture features, support vector machine, Naive Bayes, decision tree.

Non-small cell lung cancer is a prevalent disease. It is diagnosed and treated using the help of computed tomography scans. In this work, we apply radiomics to select 3D features from computed tomography images of the lung towards providing prognostic information. Focusing on cases of the Adenocarcinoma non-small cell lung cancer tumor subtype from a larger data set, we show that classifiers can be built to predict survival time. This is the first known result to make such predictions from computed tomography scans of lung cancer. We compare classifiers and feature selection approaches. The best accuracy when predicting survival was 77.5% using a decision tree in a leave one out cross validation and was obtained after selecting 5 features per fold from 219.
Design and Analysis of Novel SRAM PUFs with Embedded Latch for Robustness

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Keywords: Physically Unclonable Function, SRAM PUF, Robust PUF, Hardware Security, Non-Volatile SRAM PUF

Physical Unclonable Function (PUF) is a cost-effective security primitive to address hardware attacks such as cloning, impersonation and Intellectual Property (IP) violation. Static Random-Access Memory (SRAM) PUF has been proposed; however, it suffers from challenges, some of which are environmental fluctuations such as voltage, temperature, and noise. Ensuring the robustness of SRAM PUF under such conditions is challenging. In this paper, we propose 8T SRAM PUF with a back-to-back PMOS latch to improve robustness by 4X. We also propose a low-power 7T SRAM with embedded Magnetic Tunnel Junction (MTJ) devices to enhance the robustness (2.3X to 20X) while lowering the leakage power and area overhead.
Anti-collision Algorithms for RFID Systems

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Keywords: RFID, tag collision, anti-collision, efficiency

Radio frequency identification (RFID) systems are increasingly used for a very wide range of applications from supply chain management to mobile payment systems. In RFID systems, there is typically an RFID reader and multiple RFID tags which can communicate with the reader. If more than one tag tries to communicate with the reader at the same time, it results in tag collision, which becomes a greater problem as the number of tags increases. Collision reduction has been studied extensively in the literature with a variety of algorithms specifically tailored for low-power RFID passive systems.

In this poster we provide an extensive review study for existing state-of-the-art anti-collision protocols which can be divided into two main categories: 1) aloha based and 2) query-tree based algorithms. We compare them in terms of the two most important performance metrics: 1) efficiency and 2) communication speed (or complexity). We also look at the possibility of a 2-fold frequency division in the 902-928 MHz frequency band used for passive RFID systems. We study how such a modification in the protocol would change the number of collisions and improve efficiency for a variety of the most popular anti-collision algorithms in time-domain and explore how such frequency division could be implemented using printable analog filters.
Design and Implementation of MEMS based Oscillator

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Keywords: MEMS, Oscillator, Resonator, Sensor, High Q, Wireless Communication

In modern wireless communications, a frequency-reference oscillator is a very important frequency-setting component in any wireless transceiver systems. Traditionally, off-chip quartz crystal oscillators have been the most widely accepted choice despite its low level of integration with IC’s and limited frequency range up to 100MHz. The advent of high-Q MEMS resonators has enabled the on-chip MEMS based oscillators to be fully integrated with IC sustaining amplifier thus exhibiting a promising low phase noise at much higher frequencies than that of the quartz crystals. Furthermore, the MEMS oscillator can be readily implemented as a highly resolution gas sensor by monitoring the correlation of the added mass of the absorbed gas analyte and resultant frequency shift. Meanwhile, MEMS technology fuels further miniaturization and seamless integration of passives and various transistor integrated circuit technologies.

In this poster, an oscillator technology with high-Q MEMS resonator as its tank circuit is presented to validate its key functionality as a stable frequency reference across a wide spectrum of frequencies. Particularly, two piezoelectrically transduced MEMS resonators fabricated within a single chip are strategically designed to operate at two distinct layout-defined mechanical modal frequencies (259.5MHz and 436.7MHz). These devices were characterized and modeled by an extracted equivalent electrical circuit to facilitate the design of the oscillator using a standard circuit simulator. For this preliminary study, the MEMS resonators are integrated with the sustaining amplifier circuit using wire-bonding technique and coaxial connectors. As shown by the time-domain measurements, these oscillators are capable of locking into the resonance frequency of the constituent MEMS resonator to generate a stable sinusoidal waveform with peak-to-peak amplitude of 4.6V at 259.5 MHz and 2.3V at 436.7 MHz, respectively. On the other hand, the fundamental oscillation frequency and it harmonics can be easily observed in a measured frequency-domain spectrum. The phase noise performance is going to be rigorously investigated, which is anticipated to be on par with that of the best off-chip quartz crystal counterparts. In order to fully take advantage of this technology, low-cost and customizable integration between MEMS resonator and IC chip is going to be explored in the future by employing novel approaches, such as fan-out wafer level packaging and 3D printed interconnects.
Spintronic PUFs for Security, Trust and Authentication

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Keywords: Spintronic, Domain Wall Magnets, PUF, authentication

Spintronics have been extensively studied for logic and memory applications due to its superior energy-efficiency and non-volatility. The most promising effect is current induced modulation of magnetization dynamics discovered in MTJ and DWM as it opens door to energy-efficient logic and memory design. Interaction between injected current and local magnetization creates several Spin-Transfer Torque (STT) mechanisms that are excellent sources of entropy in the magnet. The thermally activated electrons in the material add to the entropy. Besides, the magnet is also sensitive to physical randomness. One such magnetic system with abundance of entropy is DW in permalloy nanowire (NW) with 20% Fe and 80% Ni (Fe$_{20}$Ni$_{80}$). In this poster, we present two methodologies to harvest the entropy to realize hardware security primitives such as PUF. The spatial and temporal randomness in the physical system is employed in conjunction with microscopic and macroscopic properties such as stochastic DW motion, stochastic pinning/depinning and serial access to realize novel relay-PUF and memory-PUF designs. The proposed PUFs show promising results (~50% inter-die Hamming Distance and 10-20% intra-die Hamming Distance) in terms of randomness, stability and resistance to attacks. We have investigated non-invasive attacks such as machine learning, and magnetic field attack and assessed the PUFs resilience.
Modeling the *In vivo* Wireless Path Loss

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**Keywords**: *In vivo* propagation, *ex vivo* communication, path loss model, Hertzian-Dipole, angular dependent

Our long-term research goal is to model the *in vivo* wireless channel. As a first step towards this goal, in this poster we performed *in vivo* path loss measurements at 2.4GHz and make a comparison with free space path loss. We calculate the path loss by using the electric field radiated by a Hertzian-Dipole located inside the abdominal cavity. The simulations quantify and confirm that the path loss falls more rapidly inside the body than outside the body. With the antenna effects being removed, a small range of fluctuation of the *in vivo* path loss is observed, which shows that the human body is only mildly inhomogeneous, and consequently that the path loss is only slightly angular dependent when the Hertzian-Dipole antenna is deployed. In comparison with the results obtained by using monopole antennas, we conclude that it is mostly the antenna effects that result in the significantly angular dependent path loss.
Millimeter-wave dielectric waveguide and transition suitable for
3D digital manufacturing

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Keywords: Dielectric waveguide, millimeter wave, transition, rectangular waveguide, 3D additive manufacturing.

A low loss millimeter-wave dielectric waveguide design that is compatible with 3D DDM is proposed. A transition to rectangular waveguide (RWG) has been simulated for 3 frequency bands (X, Ku and D). The proposed waveguide consist of a high permittivity core wrapped in a low permittivity cladding, and a rectangular cross-sectional geometry. The dimensions have been selected for a single mode operation.

The maximum transmission loss for the transition to RWG is 0.1 dB/mm at 170 GHz. The waveguide is designed to be printed using ceramic loaded polymers, the structure features at 170 GHz is well within the capability of current FDM tools.
**CareAlertRemote: A Support System for Dementia Caregivers**

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**Keywords:** Remote activity monitoring, Alzheimer's, Dementia, Indoor localization, Caregiver support, and Eating pattern detection

There are currently 8 million persons with dementia (PWD) being cared for by unpaid caregivers, typically relatives who are already employed full-time. As a result, these caregivers must leave the PWD unsupervised at home during the work day, leaving the PWD susceptible to many risks to their well-being due to the cognitive side effects of dementia. Unfortunately, these caregivers currently have no viable mechanism that enables them to track the safety status and well-being of the PWD while away. This inability to remotely supervise or check in on the PWD for extended periods throughout the day can induce high levels of stress, excessive leaves of absence, irregular schedules, loss of productivity, and may even lead to job loss.

We propose a new smart caregiver support system, namely CareAlertRemote, for dementia caregivers that facilitates remote monitoring and evaluation of the PWD during periods of caregiver absence. CareAlertRemote has three key components: (a) home sensor network; (b) a remote web server; and (c) web applications (browser-based and smartphone-based) for real-time monitoring. The home sensor network is a low-power wireless network consisting of diverse sensor nodes, data processing nodes, and a local server. One of the unique challenges for activity monitoring of PWDS, is their unwillingness to wear any sensors on their person. Therefore, we employ a Microsoft Kinect Sensor in a novel way to keep track of the patient (indoor localization) in real-time without them wearing a sensor. We also use Kinect sensor in a novel way to detect eating behavior. To reduce false positives as well as system power consumption, we also proposed non-visual based eating detection with numerous force and door sensors are placed around the kitchen to detect when the patient is for eating (eg., taking cutlery out of cabinet, opening refrigerator door, etc).

In this poster, we report preliminary results demonstrating the feasibility in terms of (a) indoor localization without on-body sensors; and (b) eating pattern detection based on visual and non-visual sensors. The real-time monitoring is standard web-browser based on a desktop. We also present the overall vision for the CareAlertRemote system.
Highly Reconfigurable Bandpass Filter using Microfluidically Controlled Metallized Plates

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Keywords: bandpass filters, YIG, cavity resonators

Radio frequency and microwave filters that can be reconfigured to operate within a broad frequency range are highly desired to address the size requirements of emerging multifunctional RF front-ends. Frequency-agile filters that are capable of functioning at different frequencies with similar performance (e.g. constant fractional or absolute bandwidth) are therefore currently considered as an upcoming technology to reduce the hardware and footprint requirements. Yttrium-Iron Garnet (YIG), varactor diode, ferroelectric, and RF micromechanical systems (MEMS) based filter implementations are the current technologies utilized to realize frequency-agile filters. However, the performances of these technologies are very limited in terms of frequency tuning range and power handling capability due to the fundamental device limitations. For example, varactor loadings can provide a frequency tuning range of 30% due to their restricted capacitance variation. Cavity resonator based filters can provide a wide frequency tuning range of 3:1, however, they are physically large to find use in portable devices. MEMS technologies are great in terms of miniaturization, but their tuning range is very small and can be only enlarged by resorting to tuning in discrete steps rather than the highly desired continuous tuning capability. Recently, we showed that utilizing liquid metals within microfluidic channels could provide >2:1 tuning range, while maintaining a compact filter size. However, the long-term use of liquid metals is hindered with oxidization (Galistan) and toxicity (Mercury) issues. To alleviate the use of liquid metals, in this project, we introduce a novel approach and use metallized plates within the microfluidic channels to achieve compact wide frequency range reconfigurable filters. Specifically, two filters with near constant fractional bandwidth have been designed and experimentally verified to prove this concept. The first filter is 2-poles and provides a tuning range close to 2:1 with an insertion loss (IL) below 1.7dB. The second filter is more selective due to 4 poles and provides more than 2.5:1 tuning range with IL below 3.6 dB. Micropumps were added to the system to make the filter electronically controllable. The tuning speed is characterized as 7.9ms per MHz (125.5 MHz/s) for the two-pole filter. Different design approaches are currently under test to improve the tuning speed of the filter. Since the microfluidic reconfiguration does not include active components, the presented filters present a great solution for high power handling and their power handling capability is currently being investigated.
A Novel Brain Robot Interface for Performing Activities of Daily Living

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Keywords: Brain Robot Interface, BCI, Assistive Robotics, P300, Activities of Daily Living

There have been substantial improvements in the area of rehabilitation robotics in the recent past. However, these advances are inaccessible to a large number of people with disabilities who are in most need of such assistance. This group includes people who are in a severely paralyzed state, that they are completely "locked-in" in their own bodies. Such persons usually retain full cognitive abilities, but have no voluntary muscle control.

For these persons, a Brain Computer Interface (BCI) is often the only way to communicate with the outside world and/or control an assistive device. One major drawback to BCI devices is their low information transfer rate, which can take as long as 30 seconds to select a single command. This can result in mental fatigue to the user, especially if it necessary to make multiple selections over the BCI to complete a single task. Therefore, P300 based BCI control is not efficient for directly controlling an assistive robotic device such as a robotic arm.

To address this shortcoming, a novel vision based Brain Robot Interface (BRI) was developed. This visual user interface allows for selecting an object from an unstructured environment and then performing an action on the selected object using a robotic arm mounted to a power wheelchair. As issuing commands through BCI is slow, this system was designed to allow a user to perform a complete task via a BCI using an autonomous robotic system while issuing as few commands as possible. Furthermore, the new visual interface allows the user to perform the task without losing concentration on the stimuli or the task. In our interface, a scene image is captured by a camera mounted on the wheelchair, from which, a dynamically sized non-uniform stimulus grid is created using edge information. Dynamically sized grids improve object selection efficiency. Oddball paradigm and P300 Event Related Potentials (ERP) are used to select stimuli, where the stimuli being each cell in the grid. Once selected, object segmentation and matching is used to identify the object. Then the user, using BRI, chooses an action to be performed on the object by the wheelchair mounted robotic arm (WMRA). Tests on 8 healthy human subjects validated the functionality of the system. An average accuracy of 85.56% was achieved for stimuli selection over all subjects. With the proposed system, it took the users an average of 5 commands to perform a task on an object. The system will eventually be useful for completely paralyzed or locked-in patients for performing activities of daily living (ADL) tasks.
Novel Wireless Vectorcardiogram (iVCG) Device

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Keywords: Vectorcardiography, Least-Mean Square (LMS) Algorithm, Least-Squares (LS) Method, CRM System

In this poster, we present 1) a wireless vectorcardiogram (iVCG) that is portable and placed on the chest of the patient 2) iVCG – 12-lead ECG transformation method.

The iVCG device is an ambulatory on-body device that continuously monitors the electrical activity of the heart in three dimensions, namely, the X, Y and Z dimensions. We present the minimum distance between the leads in the X, Y and Z axes, when a standard signal fidelity is maintained in the presence of noise. The target dimensions for our VCG are 3x3x2 cm. Based on our preliminary results it is possible to achieve these dimensions.

We also present the problem of transforming the three iVCG component signals to the familiar 12-lead ECG for the convenience of cardiologists. To solve this problem, we have used the least-squares (LS) method to obtain an accurately derived ECG signal (lead I) from the VCG measurements. The LS method will be employed to obtain the optimum 12x3 transformation matrix that can be used to transform the iVCG signals to 12-lead ECG. With this capability, the iVCG may become a truly transformative wireless medical device enabling continuous, advanced cardiac diagnosis.

The next steps in our research are to 1) further miniaturize the device and optimize the VCG-12lead ECG transformation process 2) develop predictive analysis technology using machine learning methods.
Broadband Miniaturized Bow-Tie Loop Antenna for UHF-RFID Systems

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Keywords: Bowtie loop antenna, UHF RFID, Circularly polarized antenna.

In this work a new broadband circularly-polarized antenna is presented for Ultra High Frequency (UHF) RFID systems. The antenna was designed to cover the European and American RFID/ISM bands (860-868 MHz and 902-928 MHz, respectively). A 4 element miniaturized crossed bowtie loop, fed by a 180 degrees power splitter and 90 degrees phase shifters was implemented to achieve circularly polarized radiation.

The simulated data shows good broadside axial ratio (< 1 dB) and a 10 dB return loss bandwidth covering the frequency range from 846 MHz up to 928 MHz, making the antenna suitable for RFID systems worldwide. Initial measurements showed good performance in the 902-928 MHz frequency band, with a broadside axial ratio of 0.7 dB. A reduction in length of 31% and an occupied footprint of 53% for a single antenna element was achieved. The performance of the single element over a ground plane as well as array configurations were also investigated.
How Does Force Feedback Improve Hexapod Walking Over Uneven Terrain?

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Keywords: robotics, robot control, legged systems, force feedback

Legged robots have promise for exploration, search and rescue, and military reconnaissance by offering a level of agility not capable by wheeled and t眼界 systems. Many current control methods can be unreliable on uneven terrain due to the use of central pattern generators that produce predefined leg motion. While this is effective on flat surfaces, poor foot placement could lead to unstable support and adaptability of the body to uneven terrain.

Humans and animals use ground reaction forces from foot placement as part of a local feedback loop to ensure proper support of the body and generation of gait timing. Inspired by biological systems, the Force Threshold Position (FTP) controller was developed to stabilize locomotion over uneven terrain using a distributed, local force feedback approach. A performance comparison of the FTP controller with two commonly used leg controllers over various terrains is presented, demonstrating the benefits of continuous force feedback in walking.
A Study on 3D-Printed Coplanar Waveguide with Meshed Ground Planes

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Keywords: Direct Digital Manufacturing, Coplanar Waveguide, Meshed Ground CPW, 3D Printing.

Direct digital manufacturing technology is gaining increasing attention for RF and microwave applications. The introduction of new materials and processes utilized by this technology has triggered the need to study their high frequency performance. Challenges with this type of fabrication include the intrinsic surface roughness of materials produced using fused deposition modeling (FDM), control of the metallization thickness, minimum feature sizes, and the tolerance on the component dimensions. In this work, a fully printed coplanar waveguide (CPW) is fabricated and characterized. The advantages of a meshed ground planes are: less conductive ink usage, better dielectric layer to layer adhesion, reduction in printing time, and it also enables the possibility of connection in between lines in a multilayer design. To the best of the authors’ knowledge this is the first study of a meshed ground CPW.
Control and Coordination of a Team of Differential and Omni Drive Autonomous Robots for the Robocup SSL

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Keywords: Multi-Robot, Autonomous, Soccer, Artificial Intelligence, Closed Loop Control, Differential Steering, Omni-Directional, Path Planning

This research was conducted with the aim of developing a hierarchical control scheme and a fast obstacle avoidance algorithm for a team of autonomous robots to compete in the Small Sized League of the Robot Soccer World Cup in 2015.

Our hierarchical control structure and obstacle avoidance algorithms were implemented in C++ and tested on an open source robot soccer simulator, grSim. Successful implementations in the simulator were transferred to a team of real robots using the standard SSL vision system and referee box.

The transfer to real differential-drive robots required several refinements to the differential-drive motion control algorithms to account for steady state errors and to decouple translation from rotation at the destination. Refinements to the omni-directional motion algorithms were also made to allow for translation while facing an arbitrary point.

A GUI showing real-time information about the robot positions was created to track the progress of the path planning algorithm.

In this poster, the refinements to the motion control algorithms, the latest control structure, and the path planning methods are displayed.
Reducing Email Traffic to Save Energy: Analysis and Design of a New Direct Email Protocol

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Keywords: Email, Energy, Hops, Analysis, Prototype, Savings, Local, Direct

The Internet consumed approximately 102.5 Terawatt hours, costing $14.3 Billion, in 2011. With the demand for, and prevalence of this technology increasing, are we using it in an efficient way? The current trend towards cloud-based computing has caused more email accounts to be hosted in massive server farms, far from the user who access them. While the push towards the cloud may get the benefit of economies of scale, it is our hypothesis that the transport cost of sending these email messages is higher than the transport cost of sending the messages directly from user to user.

I have developed a tool that, when provided with the IP address of the user's email server, traces the distance between sender, the intermediate server(s), and the desired recipient. Using a known recipient, and a known distance to the recipient's server, we can reliably compare the distance an email currently travels against the distance between the two users directly. The distance between the two users directly is representative of our new Email Protocol, where messages are routed through servers built into the users’ computers rather than through a data center. Our results so far have shown that the average email message travels approximately 30 “hops” across the network, and that by using our direct method, this distance could be reduced to around 10 hops.

My proposal is that it will be beneficial to use a server built-in to the user's computer rather than a distant server-farm. This change causes emails to be routed directly from user to user, and requires the email to take significantly less “hops” through the network, and as such drastically reduce the amount of energy each email requires to transmit. If 5% of all emails sent worldwide used this new method, I have calculated that there is a potential savings of 1.22 Gigawatt hours per year or $170k.

With this new user-to-user protocol, there are a few potential benefits. The first, and most obvious, is the potential savings from less Internet traffic. The second major benefit is an increase in privacy. If your emails are no longer stored or routed through massive server banks, the only way to collect their information would be to pull them off the network while they are being transmitted. The trade off with this new method is a loss in functionality: you can no longer view your stored messages from any device with an internet connection. With this method, your emails (those directly sent) are only visible while the computer that hosts the server is online. In the future, if the user had a local server in their home rather than hosted on their personal computer, it would be possible to work around this limitation.
Switched Capacitor DC-DC Converter for High Power Efficiency-Density and Low Electromagnetic Emission

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Keywords: DC-DC conversion, switched capacitor, integrated power converter, vlsi, circuits

Switched capacitor voltage converters provide relatively high power efficiency compared to linear regulators. However switching activity causes SC voltage converters to have spurs at the output spectrum and having capacitances in the circuit increases its area. In this research project, objective is to find new methods to improve the area-efficiency performance while also improving the output spectrum.

To achieve higher power density the area that is occupied by the capacitors must be reduced. The conventional way to do this is increasing the operating frequency but this in turn reduces the efficiency as it increases the losses related with switching activity. In this work two methods are combined to improve the efficiency. These two methods are charge recycling and resistive connection to the bulks of MOScaps. Once the efficiency is improved the frequency can then be increased to increase the density.

However the increase in frequency causes higher harmonics of the clock frequency to be a more significant problem. New methods are being developed in this work to improve the electromagnetic emission performance of these devices. These methods include modulation of the clock frequency and optimization of switch timing.

Fig 1: Implementation of charge recycling

Fig 2: Example for frequency modulation
Research Category # 4: Other
WMRA Robotic Gripper

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Keywords: CARRT, WMRA, Gripper, Robots, Robotics, Control Systems

This poster presents a self-contained robotic gripper that can be integrated into various robotic systems. Many existing grippers used in robotics today have varying capabilities and that only allow them to perform certain tasks or grab certain objects for manipulation. Additionally, many of these robotic grippers will only interface with the system they were designed to use. Additionally, these grippers may lack additional functionality (i.e. cameras or sensors) that allow them to better perform tasks. A new gripper was designed to be used with Wheelchair Mounted Robotic Arm (WMRA) to better perform certain tasks. This gripper is being made into an all-in-one product that can be added to almost any existing robotic system.

The gripper used in the WMRA features a unique cupped design that allows it to better grasp rigid objects. Additionally, it also features a camera, distance sensor, and encoder, which allow people to detect objects, find their distance, and find the position of the gripper. The integration of the gripper into a single unit that can be added to various systems was accomplished by embedding all the components necessary to control and operate the gripper (motor controller, processor, power regulation, interface, etc...) into a single control box. Additionally a software library can be integrated into existing code and allow for integration of the gripper into existing programs.
Design of a Linear Bi-stable Compliant Crank-Slider-Mechanism (LBCCSM)

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Keywords: Linear Bi-stable, Compliant Mechanism,

This poster presents a new model for a linear bistable compliant mechanism and design guidelines for its use. The mechanism is based on the crank-slider mechanism. This model takes into account the first mode of buckling and post-buckling behavior of a compliant segment to generate the mechanism’s bistable behavior. The kinetic and kinematic equations, derived from the Pseudo-Rigid-Body Model, were solved numerically and represented as plots. This representation allows the generation of step-by-step design guidelines. Design parameters consist of maximum deflection desired, material selection, safety-factor, compliant segments' widths, maximum force required for actuator selection, and maximum footprint (i.e., the maximum rectangular area the mechanism can fit inside and move freely without interfering with other components). Because different applications may have different input requirements, this paper describes two different design approaches with different parameters subsets as inputs.

The objective of this poster is to introduce a new model for linear bistable compliant mechanism and design guidelines for its customization. The guidelines will allow designers to follow step-by-step procedure to design a mechanism that would produce a linear bistable mechanism, i.e., the mechanism's displacement is parallel to the applied force. The motivation of this work is to produce predictable and controllable length change in mechanical systems, allowing the morphing of one specific shape into a different specific shape. This type of design can be used in the Shape-Shifting Surfaces (SSSs) [2] as an attachment to provide bistability to its surfaces. Common application for bistable mechanisms are switches, self-closing gates, hinges, and closures [1]. The scope of this work is to allow the design of a single or parallel/serial array of bistable mechanism. The ability to specify the mechanism’s footprint is important and a novel contribution of this work.
Using Embedded Systems to Determine the Configuration of a Static Wheelchair Mounted Robotic Arm

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Keywords: kinematics, manipulator calibration, WMRA, accelerometer, degrees of freedom, coordinate frame.

The calibration of a 9 degree of freedom (DOF) robotic manipulator using multiple three axis accelerometers and an embedded system will be accomplished in this work. The 9-DOF robotic system used in this study is a 7-DOF robotic arm attached to a 2-DOF power wheelchair. Combined they create a Wheelchair Mounted Robotic Arm (WMRA). The problem that will be solved by this thesis is the calibration of the robotic system during start up. The 7 DOF robotic arm is comprised of rotational joints only. These joints have dual channel encoders to determine the joint position, among other useful data. The problem with dual channel encoders is that when power to the encoders is turned off and the motor is moved, then the robot controller does not have accurate position data when the system is powered again. The proposed calibration method will find the angles of two joints per three axis accelerometer. Four separate accelerometers are mounted on different locations of the 7 DOF robotic arm to determine the arms joint values. To determine the orientation of the base frame, an inertial measurements unit (IMU) is mounted to the origin of the base frame. By using this system of accelerometers and inertial measurement unit, the WMRA can be completely calibrated during system start up. The results collected for this calibration method show joint estimations with an error of $\pm 0.1$ radians for each joint. The results also show an accumulation of error for joints that are farther from the base frame.
Adaptive Pulse Width Modulator with Digital Duty Cycle and Frequency Control

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Keywords: Ring oscillator, pulse width modulator, duty cycle control, frequency control, process variation, temperature variation, voltage variation, voltage regulator, current starved, voltage regulator

A controlled pulse width modulator is required for switching voltage regulator. A digitally controlled pulse width modulator (PWM) is proposed for use with a switching voltage regulator. At the heart of the implementation of the pulse width modulator, a current starved ring oscillator with digitally controlled current source headers and footers are used to provide versatile duty cycle and accurate frequency control features. The proposed circuit provides a controlled duty cycle that can be varied between 20-90% and a compensation circuit that guarantees a constant frequency of operation under process, voltage and temperature (PVT) variations. A fast response time with a fine duty cycle granularity has been achieved through coarse and fine control techniques.
A Virtual Reality System for Vocational Rehabilitation of Individuals with Disabilities

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Keywords: virtual reality simulation, vocational rehabilitation, disabilities, autism spectrum, traumatic brain injury, severe mobile impairment, activities of daily living

In this poster, a virtual reality for vocational rehabilitation system (VR4VR) that is currently in development at the Center for Assistive, Rehabilitation, and Robotics Technologies (CARRT) is presented. The aim of VR4VR is to utilize immersive virtual reality to safely and inexpensively train individuals with severe disabilities. The system enables job coaches to assess job skills of their subjects with real time interventions. Using virtual reality allows for changing job environments and scenarios easily, which would otherwise be costly and labor intensive. Most significant advantages of using virtual reality are safety, real time distracters, easy customization, automated data collection, repetitive training and motivation. Three underserved groups are aimed as target population in this study: autism spectrum disorder (ASD), traumatic brain injury (TBI) and severe mobility impairment (such as spinal cord injury (SCI) patients).

The system uses several components such as motion tracking, large curved screen, remote control interface, virtual assistive robot and Microsoft Kinect to cater to the varying needs of the wide spectrum of individuals who belong to the targeted disability groups. VR4VR involves different transferrable skill implementations taking place at controlled virtual environments. So far, implemented skills are as follows: cleaning, loading back of a truck, money management and shelving. These skills involve different interaction techniques such as tangible, touchless, 2D and 3D environments. Each skill involves tutorial sessions, training levels and levels with distracters. Levels are designed with increasing difficulty to provide the users with an effective learning environment.

Distracters constitute an important aspect of VR4VR since individuals with cognitive disabilities are prone to having fears or distractions. These distractions usually result in degraded job performance. VR4VR involves many distracters such as lightning, alarms, breakages and virtual people with different attitudes. This will enable the job coaches to find out the trainee’s fears or irritations. Job coaches will then be able to help them to overcome these irritations or make sure that they are placed at a job excluding these distractions. Testing of VR4VR with healthy individuals followed by individuals with disabilities will begin soon. The expected major outcomes of this study include an effective virtual reality job training system and a trained workforce consisting of 15 individuals with severe disabilities.
A Virtual Reality System for Vocational Rehabilitation of Individuals with Disabilities

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GTFUZZ: A Novel Algorithm for Low-Power, Robust, Discrete Gate Sizing using Fuzzy Games

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Keywords: VLSI Design Automation, gate sizing, fuzzy games, CMOS

Ultra-deep submicron circuits require accurate modeling of gate delay in order to meet aggressive timing constraints. With the lack of statistical data, variability due to the mechanical manufacturing process and its chemical properties poses a challenging problem. Discrete gate sizing requires (1) accurate models that take into account random parametric variation and (2) a fair allocation of resources to optimize the solution.

The GTFUZZ gate sizing algorithm handles both tasks. Gate sizing is modeled as a resource allocation problem using fuzzy game theory. Delay is modeled as a constraint and power is optimized in the GTFUZZ algorithm. In GTFUZZ, delay is modeled as a fuzzy goal with fuzzy parameters to capture the imprecision of gate delay early in the design phase when extensive empirical data is absent. Dynamic power is modeled as a fuzzy goal without varying coefficients. The fuzzy goals provide a flexible platform for multimetric optimization.

The robust GTFUZZ algorithm is compared against fuzzy linear programming (FLP) and deterministic worst-case FLP (DWCFLP) algorithms. The benchmark circuits are first synthesized, placed, routed, and optimized for performance using the Synopsys University 32/28nm standard cell library and technology files. Operating at the optimized clock frequency, results show an average power reduction of about 20% versus DWCFLP and 9% against variation-aware gate sizing with FLP. Timing and timing yield are verified by both Synopsys PrimeTime and Monte Carlo simulations of the critical paths using HSPICE.
A Virtual Reality System for Vocational Rehabilitation of Individuals with Disabilities

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Teleoperation of Baxter platform by Omni and Leap Motion controller

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Keywords: Teleoperation, Redundant Arm, Weight Norm Method, Singularity-Robust inverse, Baxter, Singularity, Joint Limit Avoidance, Omni, Leap Motion

Human control robot arm is a well platform for executing some tasks instead of human. For the better performance of robot arm, the redundant arm, which is 7-DOF or more, is required because human has dual 7-DOF arms. However, redundant arm causes a serious singularity problem, and it makes robot arm easily going out of control. Hence, a reliable algorithm is a main topic to produce an accuracy robot arm control system. In this poster, we create a control system with an inverse manipulator kinematic of redundant arm includes singularity and joint limit avoidance, and implement the position control on Baxter robot. The input position is obtained from the user via Leap Motion and Omni Phantomare devices. Baxter robot made by Rethink Robotics is a reliable platform with dual redundant 7-DOF manipulators. Various methods of kinematics are built for control analysis of redundancy, accuracy, singularity avoidance and joint limit avoidance. Denavit and Hartenberg (D-H) convention is achieved from Unified Robot Description Format (URDF) package. Singularity-Robust (S-R) inverse of Jacobian Matrix is introduced for singularity avoidance. And least weight norm method is combined with SR inverse to avoid joint limits. MATLAB and Unity game engine is used for simulation of teleoperation and autonomous motion and Leap Motion controller and Omni Phantomare applied as teleoperation control devices. Accuracy, control reliability and other properties are tested and compared both in simulation and physical environment.
Teleoperation of Baxter platform by Omni and Leap Motion controller

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Task Priority Based Dual-Trajectory Control for Redundant Mobile Manipulators

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Keywords: Mobile Manipulation, Motion Control, Dual-Trajectory, Manipulability measure.

In this work, we present a novel control system for redundant mobile manipulators to track simultaneously separate mobile platform and end-effector trajectories. Two Joint-dependent control variables are introduced to the task vector. These two control variables are \( D \) and \( \alpha \), where \( D \) is the Euclidean distance between the end-effector's, and the mobile platform's frames origins, and \( \alpha \) is the angle of the end-effector position vector relative to the mobile platform's frame. A singularity-robust task-priority inverse with gradient projection method is used to find solutions of a dual-trajectory tracking while, at the same time, maximize the manipulability measure for the robotic arm. MATLAB Simulation is used to test and optimize the proposed control system. The results demonstrate the effectiveness of the control system in alternating the order of priority between the two trajectories and optimizing the arm manipulability measure.
Robotics Based Human Body Model for Improvement of Upper Extremity Prostheses

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Keywords: Joint centers, weighted list norm solution, degrees of freedom

At the University of South Florida, the Robotic Human Body Model (RHBM) was created with the goal of improving prosthetic prescription, training, efficacy and design (Lura, 2012). Currently the 25 degree of freedom (DOF) model RHBM predicts the movement of able-bodied subjects by utilizing different methods. The method discussed is a weighted least norm (WLN) solution. The WLN gave a weight to penalize some joint positions in favor of other positions, and as a result quantified “human like” postures and selected the ones that were more likely to be performed by humans. The purpose of this study is to determine the optimal weights necessary for the RHBM to be adapted to predict the motion of upper extremity prosthesis user.

Two transradial amputees: R01 is right transradial using a myoelectrical device, R03 is left transradial using a body powered prosthesis, participated in the study. A Vicon motion capture system was used to collect and analyze the motions of two transradial amputees during range of motions and the following Activities of Daily Living (ADL): drinking from a cup, brushing hair, eating using utensils, lifting a laundry basket and opening a door. The motion analysis data from the actual prosthesis users were compared to the RBHM that uses WLN solution to determine the accuracy of the prediction method.

The trial of R03 the joints that represent the extension, elevation and axial rotation of the left shoulder (Joints 18-20) exhibit a large range of motion due to the body powered device, but the simulation fails to follow. In the other trials other joints overshoot their respective simulation but to a lesser extent. This happened because the algorithm assumed the person was able-bodied. Even though maximum penalization was assigned for the missing joints, the rest of the body still had the penalization from the able-bodied subjects and thus the simulation did not consider the compensatory motion. The subjects were transradial and missing only two DoFs. It is likely the simulation will deteriorate more in higher levels of amputation because the compensatory motion will be larger. However, the WLN prediction method proved to be robust and further optimization of the weights are currently being tested to improve the accuracy of simulation for the amputee population.
Passive Dynamic Synchronization of Uncoupled Rotating Systems

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Keywords: Passive Synchronization, Nonlinear Systems, Uncoupled Systems, Pendulum, Kinematic matching

Passive kinematic synchronization enables two independent dynamic systems to generate the same motion without any interaction between systems. This study demonstrates a generalized kinematic matching technique to passively synchronize two physically dissimilar systems, while also examining the relationship between kinetics and kinematics of these systems.

This method is demonstrated by matching the dynamics of systems with different masses and mass distributions. Specifically, we matched the nonlinear motion between three single-link pendulums and between two double-link pendulums. Despite the chaotic motion of a double-link pendulum, temporal and spectral analysis results show that the two different and kinematically-matched systems generate nearly identical motion. The method is generalizable and can be used to describe and match the kinematics of any open-ended rotating system chain such as rotors, cams, or pendulums. This method has implications for the modeling of system dynamics, the study of swinging limbs in humans, animals, and robots, and in prosthesis design.

With this novel synchronization method it is possible to manipulate limb movements such as evening out asymmetric walking patterns created by some trauma or neurological disorder. This can be done by adding weight to key locations along limbs. Further applications include matching healthy limb motion with a prosthetic limb yielding symmetric kinematics.

Although we have found much success in the kinematic realm of synchronization, we have only been successful in matching kinetics for certain instances including the maximum reaction force of dissimilar passive systems. This suggests that relevant applications such as prosthetic design are limited to either similar inter-limb motion or forces exerted onto joints and extremities.
A Beach Profile Numerical Model

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Keywords: Beach Profile, Numerical Modelling, Coastal Sediment Transport, Practical Application, Energy Dissipation, Swash Zone Hydrodynamics.

Developing an accurate and reliable time-averaged beach profile evolution model under normal and storm conditions is a challenging task due to the complexity of the hydrodynamics of swash and surf zone. Over the last few decades, a number of beach deformation models have been developed under limited experimental conditions and uncertainties. The present study develops a simple two-dimensional beach profile evolution model with on-offshore sand bar formation under non-storm and storm conditions based on the time-averaged suspended sediment concentration models of Jayaratne et al. (2011). These models were formulated for computing sediment concentration in and outside the surf zone under three different mechanisms: 1) suspension due to turbulence motion over sand ripples, 2) suspension from sheet flow layer and 3) suspension due to turbulence motion under breaking waves.

The suspended load is calculated by the product of time-averaged sediment concentration and undertow velocity from edge of the wave boundary layer to wave trough and mass transport velocity from wave trough to crest. Sediment transport in wave boundary layer is computed from the modified Watanabe (1982) model. Rattanapitikon and Shibayama (1998) wave model is used to calculate the average rate of energy dissipation due to wave breaking. The beach deformation is calculated from the conservation of sediment mass while the avalanching concept of Larson and Kraus (1989) is used to re-distribute the sediment mass in neighboring grids for a steady solution. Field-scale experimental and natural beach profiles from 5 high-quality published data sources from 1983-2009 (Kajima et al., 1983; Kraus and Larson, 1988; Port and Airport Research Institute, Japan, 2005, 2009; Hasan & Takewaka, 2007, 2009; Ruessink et al., 2007) are well-predicted by the proposed numerical model.

Swash zone hydrodynamics are not included in this model. An incorporation of swash dynamics, more precise evaluation of on-offshore sand bar formation and continuation to a longer time scale with precise beach deformation is recommended as the next stage of the model.
Evaluating Kinematic Variances between Tasks Attempts

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Keywords: Kinematics, microgravity, movement

In order to become proficient in any task or activity, one must practice. In becoming more skilled at a task, there may exist a reduction of unnecessary movements. A series of tasks were completed by 9 subjects; consisting of a weighted Laundry Basket Lift task and the lifting of a soda can task, both tasks have selected masses to lift. Wrist weights were also applied to subjects during the Soda Can Lift task. The hypothesis of this experiment is to compare kinematic variances of the first attempt of a task to the last attempt of a task; observing if kinematic variances exist. If these variances do exist, then the subject is adjusting for optimal performance for task completion; hence creating a learning curve. The soda can task will demonstrate perception of an unknown mass. If the soda can is empty, but the subject expects the can to be full, then exerted force to lift the can will be greater than required. Looking at the cognitive reactions between each subject will give insight on how to approach each task. This data is relevant because it will allow for proper training in different microgravity environments. This data can be applied to astronaut training to predict human motion in limited spaces under microgravity conditions; adding in astronaut safety and training.
A persistent goal of an assistant is to maintain presence. In doing so, the assistant ensures the subject is never alone. This provides a sense of security. However, trust is an important facilitator of this sense, and requires the subject to form a social relationship with the assistant.

A human assistant tasked with helping a person (the subject) with activities of daily living (ADLs) can naturally engage in conversation, engage in activities, and remember events and details. A robotic assistant, such as CARRT's Baxter research robot, needs to be programmed to do the same. The simplest ability to implement is speech. The robot's computer simply runs the speech synthesis software pico2wave to render a word or phrase as a wave file and outputs the audio through speakers. While there are many phrases that are statically programmed for certain events, the goal is to have Baxter have conversation.

The robot uses the CMU Sphinx toolkit for speech recognition. The program uses GStreamer to listen on the microphone for speech, which allows a subject to give Baxter commands easily through speaking. It also provides an opportunity to develop AI to enable Baxter to respond to speech that is not a command.

Finally, Baxter needs to recognize who it is interacting with in order to address them properly and recall important information about them, which could change the way Baxter interacts. Using OpenCV and a camera, Baxter can detect faces and recognize faces of people that it knows. Unlike humans, Baxter uses linear discriminant analysis to determine if what it is looking at is a face, and then uses the facial features to determine which face, if any, it matches in its database.

These capabilities make Baxter interactive and allow it to develop the necessary social relationships of an assistant.
Large-eddy simulation of shallow coastal flows under the influence of Langmuir Circulation, tidal forcing and surface temperature fluxes.

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Keywords: numerical simulation, ocean turbulence, vertical mixing, Langmuir Circulation

In the coastal ocean, vertical mixing caused by large-scale turbulence can have a substantial impact on coastal ecosystems, affecting temperature, salinity, nutrient concentration, sediment resuspension, light and ultimately species-specific growth and predator prey relationships. As such, a complete and comprehensive understanding of the processes affecting this vertical mixing can be helpful to external interest groups ranging from marine biologists and coastal ecologists to environmental policy makers. The present work aims to bridge some of the gaps in existing knowledge on the behavior of coastal ocean turbulence under a variety of environmental conditions.

When winds are sufficiently strong, the larger scales of the vertical mixing have been found to exist in the form of rotating, downwind-elongated cellular structures secondary to the mean flow. This phenomenon is caused by the interaction of the wind-driven shear and the streamwise Stokes drift associated induced by the surface gravity waves, and is known as Langmuir circulation (LC). In computational studies of a flow featuring a body force representative of tidal forcing and a neutrally stratified temperature profile, without the presence of wind or wave forcing, weak, full-depth stream-wise cells similar to, but less coherent than those observed in LC have been found. We have seen in preliminary testing that these cells strengthen and merge into larger cell pairs under the influence of a surface cooling flux. These cells are denoted as convective cells because they are driven by surface cooling. The previously described Langmuir and convective cells show distinct similarities in structure, and form the foundation for further testing of the influence of various combinations of forcing mechanisms on coastal flows.

Results are presented from large-eddy simulations of open channel flow with a no-slip lower wall representative of this shallow coastal ocean region. Analysis will be conducted of results from LES of flows with both a constant tidal force (representing much less than one tidal cycle) and an oscillating tidal force (representing several full tidal cycles), as well as flows both with and without LC. Surface heating and cooling fluxes will be applied to assess their impact on the strength and coherence of the turbulent structures. This impact will be quantified by turbulence statistics such as mean velocity and temperature, root mean square of velocity and temperature and colormaps of velocity fluctuations on planes of the flow domain in order to provide greater insight into the effect on secondary turbulent structures of each combination of forcing mechanisms.
Teleoperation of Baxter platform by Omni and Leap Motion controller

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Keywords: Teleoperation, Redundant Arm, Weight Norm Method, Singularity-Robust inverse, Baxter, Singularity, Joint Limit Avoidance, Omni, Leap Motion

Human control robot arm is a well platform for executing some tasks instead of human. For the better performance of robot arm, the redundant arm, which is 7-DOF or more, is required because human has dual 7-DOF arms. However, redundant arm causes a serious singularity problem, and it makes robot arm easily going out of control. Hence, a reliable algorithm is a main topic to produce an accuracy robot arm control system. In this poster, we create a control system with an inverse manipulator kinematic of redundant arm includes singularity and joint limit avoidance, and implement the position control on Baxter robot. The input position is obtained from the user via Leap Motion and Omni Phantomare devices. Baxter robot made by Rethink Robotics is a reliable platform with dual redundant 7-DOF manipulators. Various methods of kinematics are built for control analysis of redundancy, accuracy, singularity avoidance and joint limit avoidance. Denavit and Hartenberg (D-H) convention is achieved from Unified Robot Description Format (URDF) package. Singularity-Robust (S-R) inverse of Jacobian Matrix is introduced for singularity avoidance. And least weight norm method is combined with SR inverse to avoid joint limits. MATLAB and Unity game engine is used for simulation of teleoperation and autonomous motion and Leap Motion controller and Omni Phantomare applied as teleoperation control devices. Accuracy, control reliability and other properties are tested and compared both in simulation and physical environment.
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