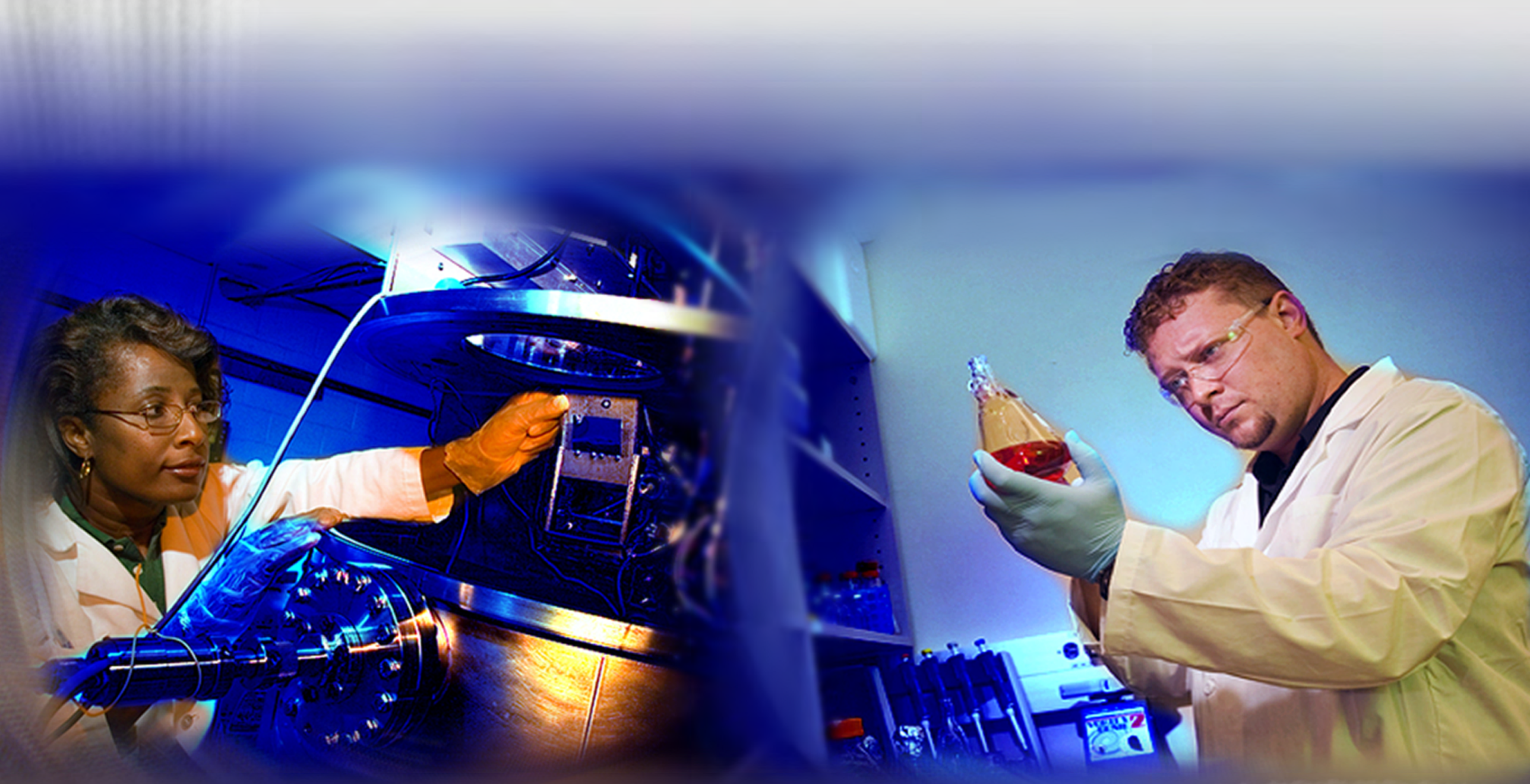
enVision
USF Engineering



Research Day 2010

Final Program

Wednesday, October 13

USF Interdisciplinary Research Building Galleria

Sponsors

USF College of Engineering

Office of Research & Innovation

Alfred P. Sloan Foundation

Research Day 2010

UNIVERSITY OF
SOUTH FLORIDA

October 13, 2010

Dear Participants,

Welcome to the 3rd Annual Engineering Research Day! The purpose of Engineering Research Day is first and foremost to highlight the important, ground-breaking research that is performed across our college, and that will have near- and long-term benefits for our local and global communities. So, this event is truly a celebration of the hard work and commitment demonstrated by our College's student and faculty researchers. We need to celebrate our accomplishments, and it is important to recognize the contributions made by our students, that make our College a vital part of the University's research mission.

The College of Engineering has over 800 graduate students, 110 faculty members and approximately 100 staff members that team together each day to support a research activity that includes $60M in active contracts and grants; these graduate students, faculty and staff are joined by more than 100 students that participate in the Research Experience for Undergraduates program. We generate several hundred research papers each year and give hundreds of conference presentations. Nearly 80 graduate student fellowships are held by our students, and over the past two years the College has generated the 2nd highest number of Ph.D. degrees per faculty member among all engineering schools in the Big East.

In the past two years the College has made important advances in several areas. Four that I would like to highlight are that:

- In 2009 we added 17 new faculty members, the largest single year increase in the College's recent history
- In 2010 we added over 100 new Ph.D. students, which is the largest single year increase in the College's history
- In 2009 and 2010, we added new training/fellowship grants (Bridge to the Doctorate, GAANN, S-STEM) to attract and retain high quality graduate students
- And, as of Fall 2010, the College has over $5M in funding from the National Institutes of Health, setting a new record, and $15M in funding from the National Science Foundation.

These 4 highlights address the ingredients for a vibrant research enterprise: faculty, students and funding. We can all be proud of these accomplishments, and should recognize that the confidence that the university places in our college, and the success of our research proposals, is in large part due to the quality research performed by our students and the positive impact this has on the reputation of the College.

The quality of our students is also recognized in another very important way that is through the receipt of nationally and university competitive fellowships and scholarships (NSF, NIH, NASA, Department of Homeland Security, Presidential, etc.). We congratulate these students on their awards.

I want to thank the Organizing Committee – Tom Weller, Ken Christensen, Dena Chastain, Bernard Batson, Becky Puskas, the rest of the College staff and student ambassadors for their hard work and efforts in making this event possible.

I would also like to express our appreciation to the Office of Research & Innovation and the Sloan Foundation for their support as co-sponsors.

Finally, I wish to thank our graduate students, faculty, and Research Centers for preparing over 130 posters. We congratulate you on your research accomplishments and thank you for your efforts in advancing the reputation of our university.

Sincerely,

John Wiencek, Ph.D.
Professor and Dean

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College of Engineering Leadership Team

John Wiencek, Ph.D.
Professor & Dean, College of Engineering

Rafael Perez, Ph.D.
Professor & Associate Dean, Academic Affairs

Tom Weller, Ph.D.
Professor & Associate Dean of Research

College of Engineering Faculty

CHEMICAL & BIOMEDICAL ENGINEERING

Venkat Bhethanabotla, Ph.D.
Professor & Chair
Molecular Dynamics, Statistical mechanics, and Molecular thermodynamics.

Norma Alcantar, Ph.D.
Associate Professor
Properties of thin films and biosystems, Conducting organic thin films, Biomaterials engineering, and Surface interactions.

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

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

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

Yogi Goswami, Ph.D.
John and Naida Ramil Professor
Energy conversion, Solar energy, Hydrogen energy and Fuels cells, Thermodynamics and Heat transfer, and HVAC.

Vinay K. Gupta, Ph.D.
Professor and Graduate Program Co-Director
Self-Assembly, Interfacial Phenomena, Polymeric Materials, Nanotechnology, and Molecular Recognition.

Mark Jaroszeski, Ph.D.
Associate Professor
Drug and gene delivery, Electrofusion, Biomedical Instrumentation, and Electrophoresis.

Babu Joseph, Ph.D.
Professor
Process modeling, Simulation and control, Sensors and signal processing, and Engineering education.

College of Engineering Faculty

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.

J.A. Llewellyn, Ph.D.
Emeritus Professor
Artificial intelligence, Data analysis, Distributed learning and Educational computing.

Carlos A. Smith, Ph.D., PE
Emeritus Professor
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.
Assistant Professor
Material science, Polymer thin films, Hydrogels, Molecularly imprinted materials, and Holographic Polymerization.

John Wiencek, Ph.D.
Dean, College of Engineering & Professor
Colloids, Protein biophysics, and Membrane processes.

John T. Wolan, Ph.D.
Associate Professor and Graduate Program Co-Director
Advanced electronic materials and applications, Surface science, and Reactor design.

College of Engineering Faculty

CIVIL & ENVIRONMENTAL ENGINEERING

William Carpenter, Ph.D., PE
Professor & Chair
Engineering education, Structural engineering, Optimization, Viscoelasticity, Fracture mechanics, and Adhesive bonding.

Mel Anderson, Ph.D., PE
Professor Emeritus
Hydraulics, Water resources, System analysis, and Fluid mechanics.

Jeff Cunningham, Ph.D.
Assistant 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.

Wayne Echelberger, Jr. Ph.D., PE, BCEE
Professor Emeritus
Environmental engineering, Environmental quality planning and management, Water pollution control, Water supply engineering, Solid and hazardous waste management, Industrial waste management, Public works administration, and Environment health and sanitation.

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

Manjriker Gunaratne, Ph.D., PE
Professor
Pavement management systems, Pavement design, and Probabilistic methods and reliability.

Stanley Kranc, Ph.D., PE
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.

College of Engineering Faculty

Jian J. Lu, Ph.D., PE
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.

Dennis J. Magolan M.S.
Instructor
Engineering education and international service learning.

Edward Mierzejewski, Ph.D., PE
Faculty Administrator & CUTR Director
Multimodal transportation planning, Transportation project evaluation, Risk analysis, and Institutional issues.

James R. Mihelcic, Ph.D.
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, StatNamic testing , and Alternative load testing techniques.

Mahmood Nachabe, Ph.D., PE
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.

College of Engineering Faculty

Linda Phillips, M.S.

Instructor

Sustainable development of water, Sanitation, Construction, Engineering education, and International service learning.

Abdul Pinjari, Ph.D.

Assistant 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, and Transportation safety.

Steve E. Polzin, Ph.D., PE

Associate Professor & Director of the Mobility Research Program

Public transportation planning and design, Mobility and accessibility, Policy analysis, and Travel behavior.

Mark Ross, Ph.D., PE

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.

Assistant Professor

Transport and transformation of pollutants in the atmospheric environment, environmental computational modeling, human exposures to air pollutants.

Alberto A. Sagues, Ph.D., PE

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., PE

Professor

Structural engineering, Bridge design, Dynamics response of structures, Dynamic behavior of piles, and Pre-stressed concrete.

College of Engineering Faculty

Daniel Simkins, Ph.D.

Assistant Professor

Nanomechanics and computational nanomechanics, Computational biomechanics and computational biology, Computational solid and fluid mechanics, Inverse problems in structural dynamics, Large-scale computation, and Parallel computation.

Peter Stroot, Ph.D.

Assistant Professor

Transport and transformation of pollutants in the atmospheric environment, Environmental computational modeling, and Human exposures to air pollutants.

Andres Tejada-Martinez, Ph.D.

Assistant 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 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.

Daniel Yeh, Ph.D., PE

Assistant 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.

College of Engineering Faculty

COMPUTER SCIENCE & ENGINEERING

Larry Hall, Ph.D.
Professor & Chair
Intelligent systems, Machine learning/data mining, Fuzzy logic in intelligent systems, and Artificial intelligent in visual pattern recognition.

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

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

Adriana Lamnitchi, Ph.D.
Assistant 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.
Endowed Eminent Scholar and Distinguished Research Professor
Applied fuzzy logic and computational intelligence, Software testing and productivity, Decision-making in uncertain environments, and Data mining.

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

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

Edward Kellner, Ph.D.
Associate Instructor
Basic programming

College of Engineering Faculty

Miguel Labrador, Ph.D.
Associate Professor & Graduate Program Director
Design and evaluation of transport layer protocols, Wireless Ad hoc and sensor networks, and Bandwidth estimation techniques.

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

Luther Palmer, Ph.D.
Assistant Professor
Biomorphic robotics, which seeks to emulate the mechanics, sensor systems, computing structures and methodologies used by biological systems, to transverse challenging terrain.

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

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

Xiaoning Qian, Ph.D.
Assistant Professor
Genomic signal processing, computational biology, and Biomedical image analysis.

Nagarajan Ranganathan, Ph.D.
Distinguished University Professor
VLSI system design, VLSI design automation power estimation and optimization computer architecture, and Heterogeneous computing bioinformatics.

Dewey Rundus, Ph.D.
Associate Professor
Human-computer interaction.

Sudeep Sarkar, Ph.D.
Professor
Perceptual organization in single images and multiple image sequences, Biometrics, Gait recognition, Color- texture analysis, and Performance evaluation of vision systems.

College of Engineering Faculty

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

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

Ralph Tindell, Ph.D.
Instructor
Computer Science Curriculum.

Rahul Tripathi, Ph.D.
Assistant Professor
Classical and quantum complexity theory, Algorithms, and Graph-theoric problems.

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

Jing Wang, Ph.D.
Instructor
Computer animation, Motion capture, and Empirical evaluation.

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.

College of Engineering Faculty

ELECTRICAL ENGINEERING

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

Adam L. Anderson, Ph.D.
Research Assistant Professor
Optimization of the MIMO physical layer link with various forms of available knowledge at the nodes and its application in the biomedical field for improving minimally invasive surgeries (MIS).

Huseyin Arslan, Ph.D.
Associate Professor
UWB, OFDM based wireless technologies with emphasis on WIMAX and IMT-Advanced, and cognitive and software defined radio.

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.

Shekhar Bhansali, Ph.D.
Professor
Bio-MEMS and Microsystems, focusing on the implementation and development of nanostructures and MEMS platforms for chemical, biological, physical sensors, biosystems, micro power generation and system integration.

Kenneth Buckle, Ph.D.
Associate Professor & Graduate Program Director
Analysis, understanding, and modeling of electromagnetic phenomena from direct current magnetic field configurations through high frequency electromagnetic problems.

Alexander Domijan, Ph.D.
Professor & Director, Power Center for Utility Exploration (PCUE)
Power Quality, Electricity Metering, Flexible AC Transmission Systems, Demand Response, Power System Reliability, Custom Power, Power Electronics and Motor Drive Systems, and FRIENDS (Flexible, Reliable and Intelligent Electrical Energy Delivery Systems).

College of Engineering Faculty

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

Lingling Fan, Ph.D.
Assistant Professor
Modeling and Control of energy systems and smart grids.

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.

Richard Gitlin, Sc.D.
State of Florida 21st Century World Class Scholar
Agere Systems Chair
Distinguished 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), and communications and networking for biomedical applications.

Justin Harlow, M.S.
Instructor
Computer Architecture, VLSI Design, Design Automation, Design Metrics, Architectures for Nanotechnology.

Rudolph Henning, Ph.D.
Professor Emeritus
Microwave research and Programs for Minority Student Success in Engineering.

Andrew Hoff, Ph.D.
Associate Professor
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.

College of Engineering Faculty

Vijay Jain, Ph.D.

Distinguished Professor

Biomedical systems, biomedical imaging and biomedical image processing, Communication systems and networks, Digital image and video processing, VLSI implementations, system on a chip (bio-sensing, DNA microarrays, opto-electronics, MEMS, digital, analog), and 3-D SOCs.

Michael Kovac, Ph.D.

Professor Emeritus

Microelectronics and Nanotechnology.

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.

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.

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.

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.

College of Engineering Faculty

Rudy Schlaf, Ph.D.

Associate Professor & Director of Undergraduate Research (College of Engineering)

Spray based deposition of macro-molecular thin films and interfaces, Photoemission spectroscopy on organic semiconductor/bio-materials interfaces, Work function measurements, Directed assembly of macromolecular materials, Biosensors, Thin film photovoltaics, and New substrate materials for Matrix Assisted Laser Desorption Ionization Mass spectrometry (MALDI-MS).

David Snider, Ph.D., PE

Professor Emeritus

Mathematical modeling in physics and engineering, numerical analysis, signal processing, differential equations, optimization, and random processes.

Lee (Elias) Stefanakos, Ph.D.

Professor & Director of Clean Energy Research Center

Renewable energy sources and systems, hydrogen and fuel cells, and electric and hybrid vehicles.

Arash Takshi, Ph.D.

Assistant Professor

Bio and Organic electronic devices, particularly in photovoltaic devices.

Sylvia Thomas, Ph.D.

Assistant Professor

Advanced Materials for applications in alternative energy sources, Sustainable environments, bio-applications for nano-electro mechanical system (NEMS) devices, and nanowires and nanoparticles.

Thomas Wade, Ph.D.

Professor Emeritus

Solid state microelectronics, VLSI multilevel inter-connection systems, test structure development, fluctuation phenomena in solid state devices, and solid state material characterization.

Jing Wang, Ph.D.

Assistant 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.

Tom Weller, Ph.D.

Professor and Associate Dean of Research

RF micro electromechanical systems, Development and application of microwave materials, and Integrated circuit design.

College of Engineering Faculty

Paris Wiley, Ph.D.

Associate Professor & Associate Chair

Energy Systems, Electric/Hybrid Vehicles, and Alternative Fuels.

College of Engineering Faculty

INDUSTRIAL AND MANAGEMENT SYSTEMS ENGINEERING

Jose Zayas-Castro, Ph.D.

Chair & Professor

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.

Griselle Centeno, Ph.D.

Associate Professor

Applied operations research, Scheduling, Decision making, Capacity planning modeling for transportation, Manufacturing, and Healthcare Systems.

Tapas K. Das, Ph.D.

Professor

Applied stochastic processes, Quality engineering, Dynamic decision processes, and Simulation based optimization of competitive and noncompetitive decision processes.

Susana Lai-Yuen, Ph.D.

Assistant 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, IIE Felow

Reliability, Maintainability, Engineering design, Automated manufacturing systems, and Quality Control.

Kingsley Reeves, Ph.D.

Assistant Professor

Supply chain management, Organizational structure, Collaborative networks, and Managerial decision making in outsourcing.

Alex Savachkin, Ph.D.

Assistant Professor

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.

College of Engineering Faculty

Michael Weng, Ph.D.

Associate Professor Computer numeric methods, Production control, Operations research, and Material resource planning.

Ali Yalcin, Ph.D.

Associate Professor & Graduate Program Director

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.

Patricia Zarate, Ph.D.

Instructor & Engineering Management Program Coordinator

Manufacturing and services systems, Application in medical devices and pharmaceutical industries, Multivariate quality control, and Statistical analysis.

Bo Zeng, Ph.D.

Assistant Professor

Discrete and combinatorial optimization, and Data mining and their applications in medical decision making and healthcare systems.

College of Engineering Faculty

MECHANICAL ENGINEERING

Rajiv Dubey, Ph.D.

Chair & Professor

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.

Glen Besterfield, Ph.D.

Associate Professor

Probabilistic mechanics, Solid mechanics, Finite elements methods, Total quality management, Bascule bridges, and Engineering education.

Nathan Crane, Ph.D.

Assistant Professor

Micro and Nanoscale assembly, Additive manufacturing/rapid prototyping processes, Manufacturing, Machine design, and Thermal protection systems for hypersonic flight.

Don Louis Dekker, Ph.D.

Adjunct Professor

Engineering design processes, and Engineering education.

Delcie Durham, Ph.D.

Professor

Sustainable manufacturing, Predictive product realization, Fundamental methods for complex systems, and Interdisciplinary research organizational models.

Nathan Gallant, Ph.D.

Assistant Professor

Biomechanics, Cell adhesion, Biomaterials, Tissue engineering, Surface functionalization, and Micropatterning.

Rasim Guldiken, Ph.D.

Assistant 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.

College of Engineering Faculty

Autar K. Kaw, Ph.D.

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.

Professor & Director, Nanotechnology Research and Education Center (NREC)

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.

Assistant Professor

Compliant mechanisms, MEMS design, Biomechanics, and Theoretical kinematics.

Ajit Mujumdar, Ph.D.

Instructor

Particle technology – Micron to Nano scale dry particle coating, Mixing and segregation, Fluidization, Granulation, Numerical simulations by discrete element method (DEM), Computational fluid dynamics, and ANN.

Jose Porteiro, Ph.D.

Professor

Fluid dynamics, Heat transfer, Separated flows, and Experimental techniques.

Frank Pyrtle III, Ph.D.

Assistant Professor

Two-phase heat transfer, Droplet and spray cooling, Micro/nano scale heat transfer, and Microelectronic device thermal management.

Muhammad Mustafizur Rahman, Ph.D.

Professor & Graduate Program Director

Modeling and simulating of thermal systems, Hydrogen liquefaction and storage, Aircraft and spacecraft thermal management, Heat transfer and air quality in buildings, Electronics packaging, Magnetic refrigeration, and Jet and spray impingement.

Kyle Reed, Ph.D.

Assistant Professor

Rehabilitation engineering, Haptics, Human-machine interaction, Medical robotics, and Engineering education.

College of Engineering Faculty

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.

College of Engineering Research Centers

1	***Center for Assistive and Rehabilitation Robotics Technologies (CARRT)***	*This Center incorporates innovative theory and state-of-the-art facilities to develop rehabilitation robotics technologies.*
2	***Center for Communications and Signal Processing (CCSP)***	*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.*
3	***Center for Digital and Computational Video (CDCV)***	*This Center provides a focal point for multidisciplinary research and education in a broad spectrum of digital and computational video.*
4	***Center for Urban Transportation Research (CUTR)***	*CUTR is a nationally recognized center of excellence in transportation issues.*
5	***Center for Wireless and Microwave Information Systems (WAMI)***	*Research done here is advancing the state of knowledge in the wireless and microwave field.*
6	***Clean Energy Research Center (CERC)***	*This Center investigates Florida's abundance of solar and biomass resources for use as environmentally clean sources of power.*
7	***Nanotechnology Research and Education Center (NREC)***	*Research at the NREC deals with diverse fields of nanoscience such as new materials, molecular and nano-electronics, nano-electroptics, nano-medicine and nano-biology.*
8	***Power Center for Utility Explorations (PCUE)***	*This Center explores energy issues comprehensively from sustainable clean distributed power to transmission, distribution and generation systems.*

College of Engineering Graduate Fellowship Recipients

NSF Graduate Research Fellowship Program (GRFP)
Frank Alexander, Jr.
Joseph Register
Dorielle Price
Tony Price
Heather Wendel Wright

National Institutes of Health (NIH) Ruth Kirschstein National Service Award
Eva Williams

Ford Foundation Diversity Fellowship Program
Brandon Henry
Julio Medrano
Dorielle Price
Al-Aakhir Rogers (Honorable Mention)

NASA Graduate Student Researchers Program (GSRP) Fellowship
Quenton Bonds
David Cure

NASA Harriett Jenkins Predoctoral Fellowship Program
Quenton Bonds

IEEE Microwave Theory, Techniques, Society (IEEE-MTTS) Fellowship Programs
Evelyn Benabe
Quenton Bonds

USF Presidential Fellowship
Jayita Das
Alexandra Oliveros Villalba

USF Graduate School Dissertation Fellowship
Yang Tan

NSF East Asia Pacific Summer Institute (EAPSI) Fellowship Program
Derek Lura
Al-Aakhir Rogers

NSF International Research in Engineering Education (IREE) Fellowship Program
Frank Alexander, Jr.
Justin Boone

College of Engineering Graduate Fellowship Recipients

Draper Laboratory Fellowship (DLP) Program
Kevin Luongo

National Consortium for Graduate Degrees for Minorities in Science and Engineering (GEM) Fellowship
Kathryn Bailey
Michael Grady
Eric Huey
Dayna Martinez
Andrea Rocha
John Shelton

NSF Sandia National Lab Internship Program
Michael Celestin

Florida Energy Consortium System (FESC)
Rudraskandran Ratnadurai
Samantha Wijewardane

McKnight Doctoral Fellowship Program
Veronica Aponte
Evelyn Benabe
Quenton Bonds
Natasha Cover
Fedena Fanord
Michael Grady
Ransford Hyman, Jr.
Brandon Henry
Julio Medrano
Erlande Omisca
Alisha Peterson
Dorielle Price
Tony Price
Javier Pulecio
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Al-Aakhir Rogers

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Shamima Afroz
Kathryn Bailey
Andrea Rocha
Innocent Udom

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Kathryn Bailey
Evelyn Benabe
Joseph Bonivel, Jr.
Natasha Cover
Michael Grady
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Alisha Peterson
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Issa Ramirez
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Rafael Rodriguez
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Justin Boone
Quenton Bonds
Vinicio Carias
Natasha Cover
Brandon Henry
Ransford Hyman, Jr.
Dayna Martinez
Ebenezer Odu
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Samuel Du Pont
Courtney Feliciani
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Patricio Garrido
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U.S. Department of Education Graduate Assistance in Areas of National Need (GAANN) Fellowship

Brian Bell
Matthew Earle
Trina Halfhide
Ryan Locicero
Mark Santana
Jamie Trahan

NSF Scholarships in Science, Technology, and Engineering, and Mathematics (S-STEM)

Graduate Scholarships to Achieve Sustainable Infrastructure at the Water-Energy-Global Nexus

Brad Akers
Pablo Cornejo
Danielle Renee DeVuyst
Joshua Girard
Kaitlin Green
Sarah Hayman
Pacia Hernandez
Leslie Knapp
Louis Lizima
Thomas Lynn
Michelle Masi
Simona Platykyte
Sarah Watson
Patricia Wilbur
Benjamin Yoakum

NSF Scholarships in Science, Technology, and Engineering, and Mathematics (S-STEM)

Engineering and Computer Scholars Targeted for Academic Retention and Success (E-STARS)

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Ransford Hyman, Jr.

College of Engineering Graduate Fellowship Recipients

Dabeegu Kabassima
Minh Tam Tran Nguyen
Yanay Pais
Tony Price
Javier Pulecio
Ana Rioja
Justin Stewart

3rd Annual USF College of Engineering Research Day
Interdisciplinary Research Building (IDRB) - Galleria
Wednesday, October 13, 2010
AGENDA

8:00 a.m. to 9:30 a.m.	**Poster Setup**
9:30 a.m. to 10:30 a.m.	**Poster Viewing**
	Refreshments
10:30 a.m. to 11:00 a.m.	**Opening Remarks** *Dr. John Wiencek, Dean & Professor* College of Engineering
	Research Presentation #1 *Dr. Maya Trotz, Associate Professor* Department of Civil and Environmental Engineering
11:00 a.m. to Noon	**Poster Viewing**
Noon to 12:30 p.m.	**Research Presentation # 2** *Dr. Piyush Koria, Assistant Professor* Department of Chemical and Biomedical Engineering
	Research Presentation # 3 *Dr. Arash Takshi, Assistant Professor* Department of Electrical Engineering
	Closing Remarks *Dr. Karen Holbrook, Senior Vice President & Professor* Office for Research & Innovation
	Lunch
12:30 p.m. to 2:00 p.m.	**Poster Viewing**
2:00 p.m. to 3:00 p.m.	**Poster Breakdown**

Opening Remarks

John Wiencek, Ph.D., is Dean of the College of Engineering and a Professor in the Department of Chemical and Biomedical Engineering. Previously, Dr. Wiencek served as chair of the Department of Chemical and Biochemical Engineering at the University of Iowa, an AAU institution. After completing his Ph.D. from Case Western Reserve University in Chemical Engineering, Dr. Wiencek joined Rutgers University as Assistant Professor. He earned his tenure at Rutgers and moved to the University of Iowa and was subsequently appointed as chair of the Department of Chemical and Biochemical Engineering.

Dr. Wiencek is an accomplished teacher and scholar, having won several national and institutional awards in both areas. He has a long list of peer-reviewed publications and presentations and has attracted over $7.5 million in research support from external, competitive funding agencies including the NSF, NIH, NASA and DOE. His research interests focus on protein biophysics and novel membrane-based water purification.

Faculty Presenter

Maya A. Trotz, Ph.D., is an Associate Professor of Civil and Environmental Engineering Department at the University of South Florida. She received her B.S. in Chemical Engineering from the Massachusetts Institute of Technology and her M.S. and Ph.D. degrees in Civil and Environmental Engineering from Stanford University. Her research, teaching and service are at the nexus of geochemistry/water quality and global/community sustainability. She teaches undergraduate and graduate courses including Aquatic Chemistry, Environmental Engineering Laboratory, and developed an interdisciplinary project based two course sequence, Sustainability Concepts: Mercury in Tampa Bay and Mercury in Guyana. She is the PI on an Environmental Protection Agency Phase II People Prosperity Planet (P3) award, a National Science Foundation Research Experience for Undergraduates site, and is also the PI on a Department of Education GAANN award entitled, "Multi-disciplinary doctoral graduate fellowship program at the water-energy-materials-human-nexus." She is the faculty advisor for USF's Chapter of Engineers for a Sustainable World, and is the departmental coordinator and co-PI for USF's SLOAN Minority PhDs program.

Faculty Presenter

Piyush Koria, Ph.D., is an Assistant Professor of Chemical and Biomedical Engineering at the University of South Florida. He did his undergraduate education in Chemical Engineering for the Indian Institute of Technology, Kanpur, India. He then went on to do his graduate work and obtained his PhD from the University at Buffalo, SUNY, in the Department of Chemical & Biological Engineering. His PhD work under the tutelage of Dr Stelios Andreadis focused on the development and application of complex three dimensional tissue engineered skin model systems for studying barrier disruption, epidermal morphogenesis and regeneration. After finishing graduate school he joined Dr Martin Yarmush's lab at the Center for Engineering in Medicine (CEM) at Massachusetts General Hospital, Harvard Medical School and Shriners Hospital for Children in Boston. Here, he developed a novel elastin based growth factor delivery platform for wound healing and worked on developing in vitro MEMs models of skin inflammation and cancer.

Dr Koria's teaching and research interests are in Tissue engineering, Biomaterials, Drug delivery, Nanomedicine, Protein engineering and BioMicroelectromechanical systems (BioMEMs). The main focus of his lab is to develop novel therapeutics for tissue regeneration specifically wound healing. He is also interested in building in vitro dynamic living models of diseases such as cancer and tissue regeneration using tissue engineering and microfabrication. He intends to use these models to understand the underlying molecular mechanisms involved in healing and develop treatment strategies for achieving better tissue regeneration.

Faculty Presenter

Arash Takshi, Ph.D., is an Assistant Professor of Electrical Engineering and a faculty affiliate in the Clean Energy Research Center (CERC) at the University of South Florida. Before joining USF, Dr. Takshi was working as a Research Assistant at the University of Maryland, where he collaborated with a research group to develop energy harvesting for wireless sensors. Also, he has been a Research Scientist at the University of British Columbia, working on the development of Organic/Bio photovoltaic devices. In addition, Dr. Takshi has more than ten publications in scientific journals.

Dr. Takshi's research interests are in Bio and Organic electronic devices, particularly in photovoltaic devices. Using proteins from natural photosynthetic cells, he has devised a photo-battery which can be charged with solar energy. Also, he has a patent on "Thin-Film Field-Effect Transistors having Schottky gate–channel junction" (United States patent No. 7649217, January 2010). The invention is a low voltage flexible transistor which can be printed on fabrics for wearable electronics.

Closing Remarks

Karen A. Holbrook, Ph.D., served as president of The Ohio State University for five years and is currently Senior Vice President for Research and Innovation and Professor of Molecular Medicine at the University of South Florida and a member of the Washington Advisory Group (WAG).

Before becoming president of Ohio State in 2002, Dr. Holbrook was senior vice president for academic affairs and provost at the University of Georgia. Prior to that, Dr. Holbrook was vice president for research and dean of the Graduate School at the University of Florida, and associate dean for research and professor of biological structure and medicine at the University of Washington, School of Medicine.

Dr. Holbrook has served on the boards of the American Association for the Advancement of Science, the Association of American Medical Colleges, the American Council of Education, the National Association of State Universities and Land-Grant Colleges, and the Association of American Universities, among others. She participates on numerous advisory panels and councils for the National Institutes of Health, including the NIH Blue Ribbon Panel for the National Emerging Infectious Diseases Laboratory, Boston, and was a recent member of the Advisory Committee to the Director of the NIH. She is currently on several boards, including the boards of the Institute for International Education (IIE), Southeastern Universities Research Association (SURA), Oak Ridge Associated Universities (ORAU), ACT, and Techne, Inc.

Dr. Holbrook has had a productive research career in the biomedical sciences and was a MERIT Award recipient from the NIH. She earned bachelor's and master's degrees in zoology at the University of Wisconsin in Madison, a doctorate in biological structure at the University of Washington, School of Medicine where she also served as a postdoctoral fellow in dermatology and a faculty member.

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Abstracts

Research Category # 1: ***Energy, Sustainability, Water and Infrastructures/Transportation***

Design of Reliable Hub-spoke Network

Y. An[1], B. Zeng[2], Y. Zhang[2], B. Zeng[1]

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Keywords: Hub-spoke network, Reliability, Lagrangian relaxation, Branch-and-bound, Large scale optimization

Hub-spoke networks are widely used in a variety of industries such as air transportation, postal delivery and telecommunications. Although they are designed to save operating costs by taking full advantage of the economies of scale, the unavailability of hub could significantly deteriorate the performance of the whole system.

In this poster we present our research on designing reliable hub-spoke network with consideration of hub disruptions. For both single allocation (SA) and multiple allocation (MA) models, mixed integer programming models are constructed. Given those models are large-scale (with up to 100,000 variables after linearization) and commercial solver (Cplex) fails to solve them, Lagrangian relaxation algorithms combined with branch-and-bound are developed to find the optimal solutions. Numerical experiments show that our method can find high-quality solutions within short amount of time (30 minutes).

DFT studies on the promotional effect of platinum for the reduction of CoPt bimetallic catalyst in Fischer Tropsch Synthesis

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Keywords: Fischer tropsch, DFT, Catalysis, Reduction, Cobalt

Cobalt catalysts promoted with small amounts of noble metals are used for this reaction of carbon monoxide and hydrogen to produce long chain hydrocarbons. The objective of this work is to investigate role of platinum promoter in the reduction of cobalt oxide using Density Functional Theory (DFT) calculations. The activation barriers and transition states for the reduction of cobalt oxide to metallic cobalt in the presence of platinum as promoter was studied using the Climbing Image Nudged Elastic Band (CI-NEB) method[1-3]. It was found that when a Pt promoter was added, the activation barrier for the reduction was reduced compared to that on an unpromoted cobalt catalyst. It was also found that the activation barrier for CO dissociation was higher on the promoted surface than on the unpromoted surface. The enhanced reducibility can be attributed to the change in the d-band center, which is due to the change in the electronic structure of the surface.

In this work, the effect of promoters on the reduction of cobalt oxides to metallic cobalt will be studied on both flat and stepped surfaces using surface alloy models where the promoter metal is dispersed on the top surface of the catalyst. Our goal is to explore the electronic effect of promoters and the influence of Co-M bimetallic bonds on the reduction of CoO to metallic cobalt to gain a better understanding of the enhanced reducibility of bimetallics. For this purpose, the activation barrier for the reaction, O + 2H -> OH + H and OH + H -> H_2O on a promoted and unpromoted Co (0001) surface will be calculated. If Pt enhances the reduction, the activation barrier on promoted catalyst will be reduced compared to that on the unpromoted catalyst. The effect of promoter on the Co sites will be examined to determine the nature of bimetallic bonds and electron transfer.

Sulfur Tolerance of Silica-Supported Platinum Nanoparticles with Size Control

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Keywords: Sulfur tolerance, Sulfur poisoning, Catalysis, Platinum nanoparticles

Sulfur poisoning is of large concern in the fossil fuel and the renewable energy industries. When a catalyst has sulfur tolerance, it does not deactivate as quickly as a catalyst that has no sulfur tolerance and there are two opposite views on whether a size dependent trend exists. First, smaller particles are thought to attract sulfur and bind more strongly causing them to be less sulfur tolerant. There is the other side that says that the smaller particles are more active than the larger particles due to sulfur surface vacancies, which does not occur with large particles, when the sulfur binds to the smaller particles. For this project, the sulfur tolerance of four different sizes (1.5, 2.9, 5, and 7 nm) of Pt nanoparticles will be tested. These particles and their catalytic properties will be characterized using X-ray diffraction, transmission electron microscopy, mass spectrometry and gas chromatography. The sulfur tolerance will be tested by executing an ethylene hydrogenation reaction with and without sulfur treatment. The sulfur tolerance of each size of particles will then be known and it will be seen which size is actually the most sulfur tolerant.

Reversible Capture of CO2 Using Calcium Carbonate

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Keywords: CO2 capture, Calcium carbonate, Sorbent preparation

The main objective of this research is to develop a simple and cost effective method that captures CO2 from power plant flue gas, as a pure stream that can be stored using regenerable calcium oxide as the sorbent. A method was developed to deposit films of these materials on ceramic fabrics, which can be used directly in a reactor designed to use these absorbents to absorb CO_2. The developed sorbent was evaluated for CO2 capture capacity using multi-cycle tests of cyclical carbonation/calcination experiments in the thermogravimetric analyzer (TGA).

The results showed that the calcium oxide sorbent developed can be used for reversible CO2 capture. Data from multi-cycle TGA experiments show that the calcium oxide sorbent is capable of an average stabilized conversion of 65% at a conditioning time of 87 hours.

Variation of temperature and pressure showed that the maximum conversion is dependent to these parameters. For example, decreasing the temperature from 750C to 700C in 80 psi increased the maximum conversion of calcium oxide from 54% to 72%. Moreover, changing the pressure from 80 psi to 110 psi at 750^0C led to a dramatic increase of maximum conversion from 0.54 to 0.71.

Based on the experimental data, a shrinking core model was employed to predict the behavior of the sample in 750C in 80 psi. The process was divided into two parts, namely reaction control and diffusion control regimes. The constants in the model were obtained by minimizing the mean square error between experimental data and model. By having these constants, reaction rate can be calculated in every second. Moreover, other characteristic of the reaction such as diffusion constant can be obtained.

Oxygen Reduction Reaction (ORR) studies of Palladium Nanoparticles (NPs) towards improved Proton Exchange Membrane Fuel Cell (PEMFC) performance

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Keywords: Energy, Catalysis, Electrocatalysis, Fuel Cells, Palladium, Nanoparticles, Cyclic Voltammetry, Linear Sweep Voltammetry, Electrochemistry, Oxygen Reduction Reaction

The necessity for clean and sustainable forms of energy continues to prompt substantial research to find alternative forms of clean energy. To this end, our work looks at the effect of monodisperse nanoparticle (NP) morphology on the oxygen reduction reaction activity from cyclic voltammetry (CV) and linear sweep voltammetry (LSV) scans of monometallic Pd. We will present synthesis results from a sequential reagent addition method, which leads to morphology control by regulation of the metal cation reduction rate, as well as characterization results from X-Ray Diffraction & Transmission Electron Microscopy. We will also discuss results from CV scans as well as preliminary temperature programmed desorption (TPD) studies. From these results, we propose preliminary conclusions on the observed correlation of the NP morphology to the ensuing activity.

Design and Simulation of a Scalable Dipole Fed Slot Antenna

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Keywords: Dipole-fed slot, Scalable, Return loss, Bandwidth, Radiation pattern

The design and simulation of a 94GHz dipole-fed slot antenna for millimeter wave imaging devices with frequency scaling capabilities is presented in this poster. The antenna illustrated a coplanar-waveguide feeding mechanism for future measuring purposes. A return loss of -36dB is achieved by impedance matching of the dipole arms and signal feed line. Over the desired frequency band, the antenna achieved 12GHz of bandwidth. The 94GHz antenna demonstrated a donut shaped bi-lateral radiation pattern on the xyz plane with resonance at the center frequency. Illustrations of results along with suggestions and future work are included.

CO_2 Mass Transfer in an Algae Airlift Photobioreactor

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Keywords: Airlift, Photobioreactor, Algae, CO2

This paper presents the results of experiments, which are being conducted to investigate the feasibility of harnessing the growth of microalgae as a means of managing several critical environmental and energy issues. Some of these issues include carbon sequestration, removal of nutrients from wastewater, fish food production, methane generation from anaerobic digestion, biodiesel production, and the generation of Fischer-Tropsch synthesis feed gas through the gasification of algae. This study focused on optimizing the mass transfer of diffused carbon dioxide into a liquid media and the microalgae's subsequent fixation of the dissolved CO_2, using a 2% CO_2/air mixture in an airlift photobioreactor at a fixed temperature. By maintaining constant temperature, gas composition, and reactor type, other factors that influence the efficiency of mass transfer and algae uptake of CO_2 can be varied and evaluated. These factors include: (i) type of bubble diffuser used; (ii) bubble intensity; and (iii) the flow rate of feed gas. The results of this study demonstrated that the level of dissolved CO_2 was optimized when a semi-coarse bubble diffuser was used in conjunction with a feed gas (2% CO_2/air mixture) flow rate of about 500 ml/min.

Comparison of Geochemistry Software in Predicting Carbon Dioxide Dissolution in Brine at High Pressure and Salinity

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Keywords: Aqueous carbon dioxide solubility, Carbon Capture and Sequestration, Geochemistry Software

Technological aspects of Carbon Capture and Sequestration (CCS) via injecting carbon dioxide (CO_2) in brine aquifers are of great interest because of the potential for reducing Greenhouse Gas (GHG) emissions to the atmosphere. Previous researchers have noted that underground sequestering of CO_2 via injection into unutilized brine aquifers possibly offers the capacity to store all power plant CO_2 emissions for the next 100 years. Estimating the storage capacity per unit aquifer volume requires accurate assessments of the mass of CO_2 stored via each of the three storage avenues: bulk CO_2 in pore space, CO_2 dissolved in brine, and precipitation of carbonate minerals. This study simulated brine and CO_2 interactions via off-the-shelf geochemistry software (OTSGS) and compared the results to the aqueous CO_2 concentrations based on a popular model which closely fits experimental data for CO_2 dissolved in brine containing high concentrations of sodium, chloride, calcium, magnesium, and sulfate ions over a wide range of CO_2 pressure. We found that CO_2(aq) predictions from various OTSGS packages range from negative 40% to positive 40% relative error (taking the popular model results as the correct values), demonstrating that OTSGS must be scrutinized carefully for applicability to high CO_2 pressure, high salinity conditions.

A Current Study to Select the Optimal Deceleration Lane Lengths at Freeway Diverge Areas

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Keywords: Deceleration Lane Length, Safety Performance, Operation, Crash, Delay

This study aims three major objectives : 1) evaluate the safety performance of deceleration lane lengths to get a better understanding of current contradictive conclusions on whether increasing deceleration lane lengths might increase or decrease crash counts, and present the suitable design requirement; 2) examine the deceleration lane lengths on operational effects by two design types (one-lane exits and two-lane exits) and present the design requirement for each type; and 3) provide a detailed technical guideline to select optimal deceleration lane lengths by combining the results from both safety and operation aspects. A total of 218 sites, which were categorized into 9 groups based on the deceleration lane lengths, were selected for the crash analysis. 360 simulation models were developed to measure the delays of through movement vehicles by the combination of the exit types (one-lane exits/two-lane exits), design speeds, exiting volumes and number of through lanes. For one-lane exits, the minimal deceleration length of 550 ft is essential for the design speed of 55 mph, 600 ft for the design speeds of 60 and 65 mph, and 700 ft for the design speed of 70 mph. For two-lane exits, the minimal deceleration length of 550 ft is suggested for the design speeds of 55 mph and 60 mph, 600 ft for the design speeds of 65 and 70 mph. For both one-lane and two-lane exit, the deceleration lane length longer than 700 ft are not recommended from the safety aspect. The result of this study could be used as a supplementary to the current design standard.

The Application of the Fermi Function and the Weibull Distribution for Modeling Survival and Resistance of *E. coli* to Photocatalytic Disinfection

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Keywords: Lipid peroxidation, Solar applications, Titanium dioxide, Water disinfection

Many different empirical models have been applied to describe photocatalytic disinfection. However, most of the applications assume first order decay and use parameters which have no real association with the underlying processes. The data also indicates that the first order decay of microbial inactivation is not always the case. Experimental determination of a survival curve usually requires a substantial effort, and the data can have a considerable scatter. What is needed is a model that can account for variations in survival curves by allowing the researcher to incorporate fundamental knowledge of the underlying mechanistic process in either predicting the disinfection outcome or at least verifying the underlying assumptions with independent data.

In this work, we explore the use of the Fermi function, which is the "mirror image" of the well known logistic sigmoid function, for modeling photocatalytic disinfection curves for *E. coli*. In the application of the function, we use the probabilistic approach and assume that the resistance to disinfection follows the familiar Weibull distribution. Based on these assumptions we show that the Fermi function along with the Weibull distribution are an almost perfect match to the disinfection curves and can account for the different shapes often observed. In addition, the shape of the Weibull distribution for the organism resistance is an indication of the effectiveness of the disinfection process for specific organism and allows us to link mortality to specific molecular events.

Thermal Gravimetric and Volumetric Hydrogen Desorption in $LiNH_2$-nanoMgH$_2$

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Keywords: Hydrogen storage, Hydride, Catalyst, $LiNH_2$, MgH_2

On board hydrogen storage is considered to be main barrier in realization of the hydrogen economy. Therefore, the development of novel hydrogen storage materials and improving their thermal gravimetric and volumetric hydrogen desorption characteristics are very important. In this study, $LiNH_2$–MgH_2 compound is prepared in both 1:1 and 2:1 molar ratios respectively. Moreover, the MgH_2 is prepared with grain sizes <10 nm using high energy milling before mixing with $LiNH_2$. 2$LiNH_2$-nanoMgH$_2$ shows promising hydrogen desorption kinetics and capacity when compared to $LiNH_2$-nanoMgH$_2$. These complex hydrides are then doped with nano-additives such as nanoNi, nanoCo, nanoTi, nanoFe and MWCNT and TiF_3. The on-set hydrogen decomposition as obtained from the TGA analyses demonstrate the increase in reaction rate with the additives in the order of TiF_3>nanoNi>nanoTi>nanoCo>nanoFe>MWCNT. Nevertheless, the TPD and TGA profiles of the doped $LiNH_2$-nanoMgH$_2$ shows the hydrogen decomposition temperature range of 150-250°C with the total hydrogen release capacity of 2-8 wt.% (see Figure 1).

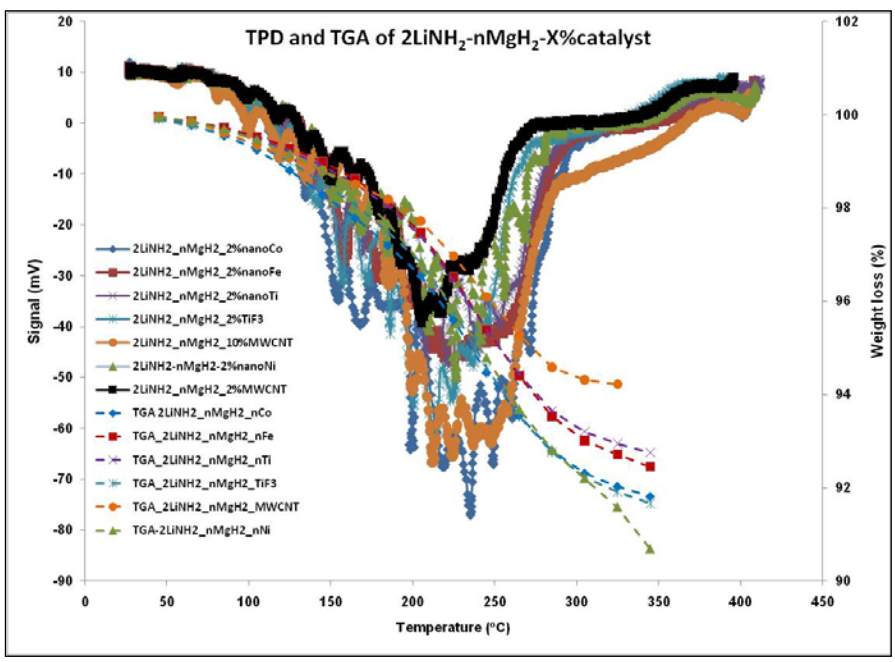

Figure 1: TPD and TGA profiles of catalyst doped $LiNH_2$-nanoMgH$_2$ (1:1 and 2:1)

Cactus-based Materials for Arsenic Separation from Drinking Water

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Keywords: Arsenic removal, Groundwater, Cactus mucilage, Cactus adsorbent, *Opuntia ficus-indica*

Arsenic contamination of groundwater continues to be a global health crisis, particularly for the worst affected communities mainly found in Bangladesh and West Bengal India. However there are also affected communities in Vietnam, Chile and Mexico. Many affected communities do not have access to conventional water treatment and are in need of accessible, reliable, appropriate technologies for arsenic removal from their drinking water. A low cost, plant-based adsorbent and a surfactant were made from the pads of the *Opuntia ficus-indica* (Nopal; Prickly pear) cactus to provide an accessible, sustainable, alternative technology for arsenic remediation of drinking water.

Cactus mucilage, a pectic polysaccharide extract from the cactus pad, was used to treat arsenic containing solutions. The mucilage bonds to the arsenic and the complex moves toward the air-water interface. An adsorbent was also made from the cactus pad which showed an ability to remove arsenic under neutral conditions. Batch experiments were run to test both materials with synthetic arsenic solutions. Hydride Generation-Atomic Fluorescence Spectroscopy (HGAFS) was used for arsenic determination while Attenuated Total Reflectance-Fourier Transform Infrared spectroscopy (ATR-FTIR) was used to characterize the materials and their interaction with arsenic. Removal rates of up to 35% by concentration were found and can be optimized by adjusting pH values and ionic strength. It is envisaged that these cactus-based materials will be used to present a viable, accessible and sustainable alternative technology for arsenic removal from drinking water.

Comparing Two Procedures for Assembling Steel Fulcra in Fixed Bascule Bridges

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Keywords: Bridge Design, Bascule Bridge, Stress Analysis, Design of Experiments, Fracture, Finite Element Analysis.

Involving shrink fitting, two procedures for assembling steel fulcra of fixed bascule bridges are quantitatively compared for the likelihood of fracture during assembly. In assembly procedure called AP1, the trunnion is shrink fitted into a hub, followed by shrink fitting the trunnion-hub assembly into the girder of the bridge. In assembly procedure called AP2, the hub is shrink fitted into the girder, followed by shrink-fitting the trunnion in the hub-girder assembly. A formal design of experiments is conducted for AP2 to find the influence of geometrical parameters such as the outer diameter of hub and various cooling methods on the design parameter of critical crack length – a measure of likelihood of fracture. For both assembly procedures, the staged-cooling method of immersing the assembly components in dry-ice/alcohol mixture followed by immersion in liquid nitrogen contributes the most to increasing the critical crack length. The assembly procedure AP2 is recommended over AP1, unless the outer diameter of the hub is large and single-staged cooling method of immersing in liquid nitrogen is used.

Preparation of Highly Active and Selective Fischer Tropsch Co/SiO2 Catalyst: Conversion of Biomass to Liquid Fuel via Thermo-Chemical Method

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Keywords: Cobalt, Silica, Calcination, Fixed bed reactor, Biomass, Diesel, Aviation fuel, Conversion, selectivity

A highly selective eggshell Fischer-Tropsch catalyst has been fabricated via interaction of hydrophobic and hydrophilic molecules on thermally treated silica gel. The physical interactions of the mesoporous silica support and the effect of catalyst preparation conditions on the performance of the cobalt/SiO_2 were explored. It was found that dispersion and performance of the FT cobalt/SiO_2 catalyst were significantly affected by the preparation technique used. In this study we focus on two key variables: the solvent used during the precursor loading and the calcination atmosphere. Silanol groups on the silica surface and near-surface regions can alter morphology and dispersion of the supported active metals. Solvents used for precursor such as water or alcohol attach to these silanol sites in specific configurations and compete with metal salts during ion exchange and adsorption. By fine tuning the solvent attachments on heat treated silica we have fabricated a cobalt/silica catalyst with high dispersion and low metal loads. Additionally, since silica has affinity for both polar and non-polar molecule depending on the surface conditions; this property has been exploited in preparing an engineered eggshell profile. This together with simultaneous calcination/ reduction in a dynamic hydrogen environment has been shown to further enhance dispersion and reducibility. Characterization techniques including BET, XPS, XRD, H-chemisorption and FTIR were employed. Catalyst activity, product selectivity, distribution and conversion were studied using a bench scale fixed bed reactor fitted with a GC/MS instrument.

A Freshwater Recirculating Aquaculture System's Mass Balance on Nitrogen

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Keywords: Freshwater, Recirculating, Aquaculture, Nitrogen, Mass balance

The rapid increase in world population during the 20th and 21st centuries, from 3 billion people in 1960 to approximately 6.8 billion people in 2008, requires the production of ever more food. A necessary component of human food is protein. The most protein rich food sources are meat, fish, and dairy products. Of these three protein rich food sources, fish is considered the most desirable protein source for a variety of reasons. Due, in part, to this perception, the world consumption of fish has increased rapidly during the last four decades.

Fish are obtained from two sources: capture and aquaculture. In 2006, these two sources produced approximately 110 million tons of fish and related products. Of this total, aquaculture accounted for 47 percent. The maximum world potential for sustainable fish capture has been reached. Due to population growth, a shift in diet towards more animal products by developing countries and in industrial countries, environmental and safety concerns, aquaculture production will have to fill the predicted global demand for fish consumption.

Aquaculture production occurs in a variety of forms: ponds, cages, raceways, and recirculating systems. Arguably, the most environmentally friendly form is the recirculating aquaculture system (RAS). The RAS is typically land based and defined as recirculating all but 10% or less of its total water volume per day. This 10% discharged water contains waste products that include nitrogen, a necessary nutrient for fish growth. This water is typically discharged to the environment, treated or untreated for nitrogen removal, according to local policies.

This study investigates the environmental discharges of nitrogen in a sturgeon grow out recirculating aquaculture system at the Marine Aquaculture Park (MAP) in Sarasota, Florida. The calculation for their nitrogen discharges to the environment requires the creation and verification of a nitrogen mass balance. Verification of this mass balance calculation is accomplished, in part, by measuring the nitrogen content of the system's influent and effluent points.

RAS is a process that will continue to grow as a necessary component of our world food production. A better understanding of the RAS's mass balance on nitrogen will maximize its sustainability.

The Impact of Large Scale Integration of Photovoltaic Sources on the distribution Grid – Modeling and Simultion

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Keywords: Virtually Central Generation (VCG), Voltage Source Control (VSC) converter, Large Scale Photovoltaic plant.

The path towards deep penetration of renewable or solar energy sources such as photovoltaic, wind, geothermal, tidal, hydro-electric or solar thermal is naturally hindered by the scarcity of resources in geographic locations. The abundance of each resource is localized naturally. This hindrance can be overcome by smart interconnection or switching algorithm to meet energy demand. Some of the common challenges other than geographic boundaries are the power intermittency, frame ware and hardware to extract useful power out, its impact on local ecological system and the process of transmission. As an example, there could be multiple conversion stages that could introduce losses leading to poor efficiency and thus might be deemed. The standard or code compliance requirement may impose additional design complexity; the utilization of solar energy in a large scale may introduce unbalance in its natural distribution on earth surface - that may cause even worse effects on climate change and thus needed to be foreseen. The dismantling and recycling of inoperable components issues cannot be ignored. Thus the impact of deep penetration on the power system is to be assessed from different viewpoints – reliability, power quality, risk and sustainability. Apparently, the assessment needs to be done prior to any large scale deployment. The simulation of those systems requires models to be developed accordingly, otherwise the result may mislead to inappropriate design of the system causing financial loss. Similarly a series of successful attempts at deploying small systems should attract the stakeholders raising the confidence level on the potentials and deep penetration will become reality. The research addresses system prototype development with keen attention to the associated risk if it is extrapolated to larger system.

Biodegradation of Endocrine Disrupting Compounds Under Alternating Aerobic/Anaerobic Conditions

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Keywords: Soil-aquifer treatment, Bisphenol-A, 17β-estradiol, Redox condition

Soil-aquifer treatment (SAT) has been proposed as a method for reusing treated municipal wastewater. SAT is characterized by alternating cycle of aerobic and anaerobic conditions. It is not yet known how these alternating conditions affect the removal of harmful endocrine disrupting compounds (EDCs). To distinguish between sorption-based and biodegradation-based removal, we measure the lag-phase and rate of biodegradation depending on the period of alternating cycles in simulated SAT system. We consider the bisphenol-A (BPA) and 17β-estradiol (E2). Experiments are performed in batch microcosms containing soil and treated wastewater spiked with the target contaminants. The 4 L reactor was used for simulated SAT system, and 500 g sediment from a wetland and 3 L effluent from a waste water treatment plant were placed in the reactor. The important innovation is the linkage of the observed EDCs degradation to the prevailing redox conditions (alternating aerobic/anaerobic conditions) in the simulated SAT system. Biodegradation is differentiated from sorption, and the rate of biodegradation is investigated depending on the alternating aerobic/anaerobic condition. We quantify the removal of EDCs by the process of biodegradation; and most significantly, we measure how the lag time of microbiology during SAT depends upon the transient redox conditions, which are controlled by the system operation. This information is necessary to determine an optimized SAT operation time in order to get high removal efficiency of targeted material.

Stochastic Optimization of Power Supply Systems in Isolated Islands with Renewable Energy

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Keywords: Stochastic Programming**,** Mixed Integer Programming, Green Energy Generation and Storage, Bender's Decomposition

Supplying energy to isolated islands can be very expensive using diesel generators or transmission equipment from mainland. In this work, to meet the demand in one island, we consider a hybrid system with diesel generators, a wind farm, and the transmission line from the mainland. A stochastic mixed integer programming model is developed to account for variability in demand and wind speed. An algorithm utilizing Benders' Decomposition is developed and the computational performance is presented.

Exploiting Metal-Support Interaction to Optimize Dispersion and Reducibility of a Highly Active & Selective Fischer-Tropsch Synthesis Catalyst

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Keywords: Catalysis, Fischer-Tropsch Synthesis, Chemical Engineering

The use of water in synthesizing FTS catalysts was shown to either enhance ionization or eventually lead to recombination of the available precursor active Co^{2+} ions during deposition onto a silica support. In this experiment, the precursor salt ($Co(NO_3)_2$ *$6H_2O$) is dehydrated and dissolved in anhydrous ethanol under low humidity nitrogen atmosphere and titrated with anhydrous ethanol-urea solution. An addition of small amounts of de-ionized water followed by titration ionizes the solution. However, higher amounts of added water can either aid in the ionization of salt or lead to recombination of ions during titration resulting in higher or lower, respectively, metal-to-surface interaction. During deposition, the static charge potential of silica interacts with free Co^{2+} ions by electrophoresis, crossing from the diffused ion layer and attaching in the stern layer near the silica surface. Thus the amount of free Co^{2+} ions formed in solution increases the potential for cobalt-silica surface interaction and leads to the overall dispersion and reducibility of cobalt on the catalyst surface. The optimum urea-water-ethanol proportions were found via conductivity tests of solutions throughout the titration process. Hydrogen chemisorption tests on previously prepared catalysts show the increase in metal dispersion for 4% by volume water addition, corresponding to the plateau of solution conductivity in 4% water solution.

Cobalt Nanoparticles on Surface Modified SiO_2 for Fischer Tropsch Synthesis

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Keywords: Cobalt Nanoparticle, Catalyst, Fischer Tropsch Synthesis

Growing concerns of pollution, in addition to the rapidly depleting oil reserves, motivate research in catalytic technologies for production of clean synthetic hydrocarbon fuels such as Fischer Tropsch Synthesis (FTS). Cobalt metal is known for its FTS catalytic activity, selectivity, stability and relatively lower negative effect of water-gas shift reaction than iron-based FTS catalysts. In the quest for improvement of FTS activity, a rational strategy to achieve high throughput is to enhance cobalt dispersion and surface-to-volume ratio by decreasing the average cobalt nanoparticle size. However, literature reports on FTS activity are scattered and controversial for cobalt nanoparticles especially in the 2-12nm regime. We have focused on the synthesis of novel nanocomposite colloids such as surface modified silica supports that are decorated with nanoparticles of cobalt of different sizes. Conventional methods of preparation that rely on reduction of cobalt precursor to metallic cobalt at high temperatures (~350-700°C) and pose challenges due to catalyst deactivation from the sintering of pores of the support, agglomeration of cobalt nanoparticles, and reaction with the silica support to cobalt silicates. Cobalt nanoparticles with extended stability in solution are synthesized by thermal decomposition of a cobalt pre-cursor. The nanoparticle size can tuned by changing the reaction conditions and then be easily immobilized onto the surfaces of silica micro-particles that are surface modified with both small ligands and polymer chains. The interaction of cobalt nanoparticles with the modified silica depends upon parameters such as the functional groups of the small molecule ligands and polymer chains as well as the cobalt precursor and solvent medium that are used. Our method not only avoids the limitations of conventional impregnation techniques but also provides several benefits such as increased availability of monodisperse cobalt nanoparticles on the surface of the silica supports, ease of preparation, and manipulation of cobalt loading. Our goal is to use *in situ* FTIR techniques to study the impact of cobalt nanoparticle size in actual FTS reaction conditions. In this presentation, the various methods of preparation will be discussed along with the characterization of the novel nanomaterial using FTIR spectroscopy, X-ray diffraction, dynamic light scattering, electron microscopy, temperature programmed reduction and hydrogen chemisorption.

Improving the Energy Efficiency of IEEE 802.3az EEE by Packet Coalescing

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Keywords: Energy Efficient Ethernet, Packet Coalescing, Ethernet, IEEE 802.3az Standard

It is estimated that networked devices consumed about 150 TWh of electricity in 2006 in the U.S. which has cost around $15 billion and contributed about 225 billion lbs of CO2 to greenhouse gas emissions. About 13.5% of this energy is consumed by network equipment such as switches and routers. This research addresses the energy consumption of Ethernet, and designs and evaluates an improvement on an existing standard to reduce the energy consumption of Ethernet links.

Energy Efficient Ethernet (EEE) is an emerging IEEE 802.3 standard which allows Ethernet links to sleep when idle. In this research, a performance evaluation of EEE is completed. This evaluation replicates previous work by Reviriego et al. in an independent manner. The performance evaluation shows that EEE overhead results in less energy savings than expected. A new method based on Packet Coalescing is developed and evaluated to improve the energy efficiency of EEE. Packet Coalescing bursts packets such that EEE overhead is minimized. The results show that EEE with Packet Coalescing for 10 Gb/s Ethernet can achieve very close to ideal (or energy proportional) performance at the expense of an insignificant added per packet delay.

Environmental Health Implications of Household Water Storage Practices in Developing Countries

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Keywords: Water quality, Household water treatment, Water storage tanks, Environmental health

Unintentional decentralized water supply and treatment is the norm for many parts of the developing world due to inconsistent water quantity/quality provision from publicly funded utilities. Common throughout Caribbean and Latin American households are commercially available HDPE storage tanks, and aluminum and concrete tanks with multiple levels of treatment between the tank and point of use that depend on socio-economic factors and hygiene/public health awareness. While these systems help to guarantee a more constant supply of water, they may impact water quality when it does reach the household tap, particularly concentrations of bacteria and chemicals in the water. The goal of this research is to understand how households use water storage tanks and determine the effect of these tanks and the individual practices on water quality. Our results from field sites in Bolivia, Guyana and Trinidad and Tobago indicate that households retain tanks for several years, tank cleaning practices are uncommon as are disinfection, and the tanks have high total and fecal coliform, turbidity and heavy metal levels. In understanding the needs of the residents and communities, effective approaches can be implemented in regards to environmental health awareness, sustainability, and water monitoring.

The Impact of Inter-firm Strong Ties on Environmental Sustainability

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Keywords: Sustainable Supply Chains, Environmental Management, Social Network Analysis

The literature indicates that an increased level of integration across the supply chain is necessary in order to pursue a sustainability-focused strategy. Several methods for measuring vertical integration exist; however, all of these methods rely exclusively on economic data. My research introduced the use of social network analysis in supply chain management research to assess "connectedness" along social dimensions. The intent is to determine if there is a correlation between "connectedness" and the pursuit of a sustainability-focused strategy. Employing social network analysis, this research examined the collaboration of sustainability focused companies with their first and second tier suppliers to understand the supply chain coordination that helps fostering knowledge transfer and organizational performance.

The study makes two contributions. First, we developed the theoretical foundation for linking sustainability strategies to organizational structure. Second, we empirically examined the vertical integration level of 144 sustainability-focused companies in 9 different industries. The results demonstrated that sustainability-focused companies in the Health Care Industry and the Industrials Industry tend to have more vertically integrated organizational structures than their industry competitors that are not pursuing such a strategy.

Absorption and Dispersion of Oil by Cactus Mucilage

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Keywords: Opuntia ficus-indica, Cactus, Mucilage, Filtration, Absorption, Adsorption, Dispersion

Oil spills can affect water quality, wildlife, overall environmental quality, and public health issues. To help maintain global sustainability of human health and welfare we must develop ways to filter and clean our existing water resources. Of particular interest is the absorption and filtration of environmental contaminants from man-made systems such as oil spillage and its conglomerates with non-toxic natural materials.

This research aims to investigate cactus mucilage-based filtration as a viable treatment for water purification. The mucilage is an extract from the *Opuntia ficus-indica*, commonly known as Nopal or Prickly pear cactus. This readily available and inexpensive natural extract has been shown to remove turbidity, bacteria and arsenic from synthetic water in laboratory trials. The research hopes to prove oil can also be absorbed, dispersed and filtered from water by studying the interaction between the oil and mucilage. Trials are conducted while oil is at the surface and emulsified in a water solution, both de-ionized and saline. With this research we hope to design a non-toxic, inexpensive, and sustainable oil remediation treatment.

Fast Clustering on Location (GPS) Datasets

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Keywords: Locations of interest, Great circle distance, Hierarchical clustering, K-means clustering

We present a novel clustering algorithm which pairs points based on a "buddy system". Our clustering algorithm is used to extract locations of interest, a location where the user idled for a certain amount of time, from GPS data collected by a user over a day. Similar to other (hierarchical) clustering algorithms, pairs of disjoint sets are merged. However, in our case, we do not update a table or global "picture" of sets once a union has occurred. Instead, we exhaust a list of triples (i, j, *r*) where i and j are the ith and jth indices of two unique elements in an enumerated list of elements and r is the distance between them. In other words, this list of triples maintains the distance between individual pairs of elements (under a certain distance) prior to merging. The triple that our algorithm operates on is two gps points (for the ith and jth elements respectively) and the great circle distance (global or spherical distance between GPS points) as *r*. From this list of triples we pair elements not unlike a normal clustering approach.

Each unique element is considered as the root of its own cluster (a balanced binary tree) to which other sets can be added to. A single element is regarded as a singleton set. For this cluster we maintain a list of indices, which maps to elements in the enumerated list of elements, and a root index which is the enumerated index of the root in the tree. For an iteration of our algorithm we simply add indices from one cluster to another and perform a set union between the two disjoint sets if any of their elements are less than a certain distance within each other. We then update the root index of the mapping for each of the elements in the merged set so that the algorithm will refer to the root of the cluster. In this way, when merging disjoint sets we do not create any loops within a single cluster or an incorrect union between some subtree (rooted at the element) and the other set.

Our (ordered by distance) list of triples gives the pair of points that must be paired. By applying the aforementioned procedure to each pair of elements at the indices of our triple we will generate the same output as a traditional hierarchical clustering approach.

On a set of 939 GPS points our algorithm took 34 seconds. The traditional k-means hierarchical clustering algorithm took 2 minutes and 7 seconds on the same set of GPS points. The efficiency of our algorithm is especially beneficial for our datasets which consists of GPS points collected over several hours to a day.

Multicompartmental Nanofibers via Electrospinning and Their Applications

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Keywords: Electrospinning, Nanofibers

Electrospinning is a low-cost, yet efficient deposition technique for fabricating nanofiber structures. A high voltage supply, syringe, polymer-based solution, substrate, and ground plate are all the necessary components needed. Recently, there has been a phenomenal breakthrough in the design of composite nanofibers via dual or triple syringe setups. Two and three-layer nanofibers have been constructed for experimentation in filtration and optical properties. The advantage of using this technique is that each material maintains its own characteristics while performing coincidently with adjacent nanofibers. In this research, advancements will be made in addressing the unknown properties of these multicompartmental nanofibers and comparison to thin film structures. Materials such as ZnO, NiO, Fe3O4, SnO, and TiO will be deposited and examined. In particular, surface plasmon resonance, photoluminescence, crystallography, and fabrication advancements will be made. Also, amperage effects on the electrospinning technique will be addressed. A syringe pump bank will be used to control the flow rate of our desired solutions. Concurrently, the basic electrospinning setup will be modified to catch our deposited nanofibers in a unique structure designed for multiple application purposes.

Catalytic Conversion of Glycerol over Nickel Supported on $AlPO_4$ and Si-Al Oxides

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Keywords: Glycerol, Nickel, Aluminum Phosphate, Dehydration, Silica-Alumina Oxides

It is evident that our dependence on fossil fuels has created not only environmental pressures but also economic distress. Therefore, the necessity for a renewable-based process to acquire commodity chemicals is growing. Approximately 89 million metric tons of organic chemicals and lubricants are synthesized annually in the United States—the majority derived from fossil fuels. At this rate, experts predict the end of cheap oil around 2040 at the latest. Glycerol is derived from the synthesis of biodiesel by transesterification of vegetable oils or animal fats. For every 9kg of biodiesel created, 1kg of glycerol is made as a byproduct. The market has reacted strongly to the high availability of glycerol, dropping its market price, and making glycerol a potentially important and inexpensive biorenewable feedstock. Being highly functionalized, glycerol can be oxidized, halogenated, esterified, etherified, and reduced to produce commodity chemicals such as dihydroxyacetone, mesoaxilic acid, 1,3-propanediol, 1,3-dichloropropanol, glyceryl ethers, glycerol carbonate, glyceryl esters, acrolein and 3-hydroxypropionaldehyde.

In the current research, we intend to derive commodity chemicals from the conversion of glycerol using two catalysts made of Ni supported on $AlPO_4$ and SiAl oxides. Finding a suitable catalyst for this conversion will create an alternative synthesis method from the current oil-dependent one. It will also lower the production cost of biodiesel and thus make biodiesel more competitive in the market.

After reviewing the literature, we hypothesize that the dehydration of glycerol produced two commodity chemicals: acrolein and 3-hydroxypropionaldehyde. A solid acid catalyst was proposed since dehydration reactions occur through elimination mechanisms which required strong acids. The nickel content was varied from 1% – 10% by weight and the dehydration was performed on a 50mL batch reactor at constant temperatures ranging from 150°C to 250°C and atmospheric pressure. After the reaction started, 0.2mL samples were taken in intervals of 30 minutes for 8 hours. Glycerol conversion and reaction products were measured by various means including gas chromatography and nuclear magnetic resonance spectroscopy. Also, a thermodynamical study was performed on dehydration reactions of oxygenated molecules and used to help analyze the reaction process. This was achieved by simulating the equilibrium compositions of species after dehydration occurred at different temperatures with the aid of a Matlab program. The catalyst was characterized before and after the catalytic reaction by several methods including X-ray diffraction, surface probes techniques, and temperature-programmed methods to correlate the reaction results to the physiochemical properties of the catalyst.

We expect to find an alternative way to commodity chemicals from the readily available glycerol. The acid catalyst was chosen after careful literature review and different compositions were used. The catalyst was characterized before and after the conversion and the reaction products were analyzed with different techniques.

Geochemical Modeling of CO_2 Sequestration in Deep Saline Aquifers in Florida

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Keywords: Geochemical modeling, Non-linear geochemistry, Carbonate aquifer

Geologic sequestration of carbon dioxide (CO_2) in a deep, saline aquifer is being proposed for a power-generating facility in Florida as a method to mitigate contribution to global climate change due to greenhouse gas (GHG) emissions. The proposed repository is a briny, dolomitic-limestone aquifer with anhydrite inclusions contained within the Cedar Keys/Lawson formation of Central Florida. Thermodynamic modeling is used to investigate the geochemical equilibrium reactions for the minerals calcite, dolomite, and gypsum with 28 aqueous species for the purpose of determining the sensitivity of mineral precipitation and dissolution to the temperature and pressure of the aquifer and the salinity and initial pH of the brine. The use of different theories for estimating CO_2 fugacity, solubility in brine, and chemical activity is examined and found to be relatively insignificant. Nine different combinations of thermodynamic models are tested and all predict that calcite and dolomite will dissolve and gypsum precipitate, with good agreement among the quantities estimated. Over the range of values examined, it is found that net mineral dissolution and precipitation is relatively sensitive to temperature and salinity, insensitive to pressure and initial pH, and does not indicate that significant changes to porosity will occur.

Thermal Energy Storage for Concentrated Solar Thermal Power plants

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Keywords: Thermal energy storage, Concentrated solar power, Latent heat storage

Though many renewable energy technologies are often plagued by the intermittent and unpredictable nature of the energy source, concentrated solar power (CSP) plants are able to overcome this hurdle by possessing the capability of storing thermal energy which can be retrieved from the system and used to level the fuel supply. There are currently three modes of thermal energy storage: latent heat, sensible heat, and thermochemical storage. Though sensible heat storage is the only method used to date, latent heat storage is regarded as a promising approach due to its high energy density and isothermal storage process. Different thermal storage technologies and methods used for concentrating solar power plants will be presented. Experimental and numerical research being performed at the Clean Energy Research Center at USF to develop a novel latent heat storage system for use in CSP plants will also be presented.

Effects of Climate Extremes on a Lake-Groundwater Interactions

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Keywords: Climate Extremes, Karst Lake, Lake-Groundwater Interactions, Hydrological Modeling

Natural lakes in the central Florida are an important and unique part of the landscape. These lakes, referred to as seepage lakes, are typically shallow and can experience large fluctuations in their extent and persistence. Over half of Florida's 8000 or more lakes are seepage lakes, closed lakes that rely predominantly on rainfall and shallow groundwater as inflows. Long-range variability in climate and climate extremes produce changes in seepage lake levels that are difficult to forecast because they also affect groundwater interactions with the lake, and those indirect effects are not well known. Climate extremes due to El Nino Southern Oscillation (ENSO) events between 1996 and 2006 had substantial effects on lake hydrology in central Florida. The lake stage varied over 13 feet during the 10-year study period as a result of rainfall varying from 30 inches /year to over 75 inches/year against the long-term average of 52 inches/year. The approaches currently used to define basin topography and lake bathymetry within 3-dimensional finite-difference model grids make it difficult to accurately represent the fluctuating lake surface area and thickness of the unsaturated zone in the basin, especially near the lake. In addition, the spatial distribution of flow through lakebeds can become oversimplified because bathymetry is represented by rectangular model grids. This study focuses on the computer modeling technique to study the effects of these climate extremes (heavy rainfall, hurricane, and drought) on the lake-groundwater interactions at Lake Starr. LiDAR data (Light Detection And Ranging) and bathymetric survey data was used to develop a seamless topo-bathymetry of the model domain to accommodate the large fluctuations in lake surface area corresponding to the dynamic lake levels.This modeling approach can be applied to other similar systems like wetlands, playa lakes, and other surface-water bodies with large changes in surface area.

Effect of Incubation Temperature on Accuracy of Three Methods for the Enumeration of Total Coliform and *Escherichia Coli*

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Keywords: *E. coli,* Total coliform, Water quality, Developing countries, Enumeration

Access to clean, reliable drinking water, remains a major problem for most of the developing world. It has been estimated by the World Health Organization that waterborne diseases are responsible for the death of approximately 3.4 million people each year, mainly in developing countries, making it the leading cause of disease and death in the world (1). Therefore, it is important to have a method to measure water quality. *E. coli* and other coliform bacteria are often used as an indicator of water quality, and there are a variety of tests available to measure these indicator organisms. The majority of tests on the market require incubation, which can be problematic in developing countries with little or no access to electricity. The purpose of this study is to test how three different testing kits, Coliscan Easygel (Micrology Laboratories), 3M Coliform/*E. coli* Petrifilm plates (3M) and IDEXX Quanti-trays (IDEXX), perform under non-ideal temperature conditions. These results were then compared to the same test at standard temperatures to see which test produced the most accurate results.

Each of the above three kits were tested at steady states of 21.9° C (room temperature) and 27° C and were then compared to the standard condition of 35° C. The 3M and Easygel tests were allowed to run for 48 hours with readings taken approximately every two hours starting at hour 24. The Quanti-trays were allowed to run for 32 hours with readings taken every two hours starting at hour 18. At 27° C the 3M plates had comparable *E. coli* counts at 40 hours. The 3M plates at 21.9° C never achieved the same colony counts as at standard temperature. At both 27°C and 21.9° C, the Easygel plates never produced the same results as the standards. At both 27°C and 21.9° C the Quanti-trays never produced the same results as the standards.

Catalytic Hydrothermal Conversion of Triglycerides to Non-ester Biofuels

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Keywords: Catylitic Hydrothermolysis, Napthenic HRJ, Non-ester Green Diesel

This describes a catalytic hydrothermolysis (CH) process aimed at converting triglycerides to non-ester biofuels. The CH conversion was carried out at temperatures ranging from 450 to 475 °C and a pressure of 210 bar in the presence of water with and without a catalyst. The organic phase (biocrude) from the CH process underwent post-treatment involving decarboxylation and hydrotreating. Results derived from soybean oil, jatropha oil, and tung oil show that certain biofuel fractions met JP-8 specifications and Navy distillate specifications. One of the CH biofuel characteristics is their high levels of cyclics and aromatics. Tung-oil-based biofuels derived from the CH process contain up to 60% aromatics, which can be a desirable ingredient for fuel blends involving biofuels derived from other processes or feedstocks. Results from these crop oils also suggest that the CH process can be adapted to a variety of other triglyceride feedstocks.

Development of High Density Cylindrical Ion Trap Array Mass Spectrometer

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Keywords: Cylindrical Ion Trap, Mass Spectrum, Specificity, Sensitivity, SIMION

This poster presents the development of high-density cylindrical ion trap array for mass spectrometer (CIT-MS). A new structure of Cylindrical Ion Trap has been proposed as the essential ion-deflecting component of MS, with specific address on reducing the parasitic capacitance between endplates electrodes and ring electrode. The capacitance is a key factor to determine the RF signal amplitude applied on the ring electrode and thus determine the range of mass spectrum. Based on simulations, a parasitic capacitance of at least 12 times smaller than previous design is being expected without sacrificing spectrum resolution.

In this newly developed generation of CIT-MS, the geometry design of CIT has been focusing on increasing the gap between the ring electrode and endplate electrode and reducing the overlapping area of endplate electrode and ring electrode. KOH/DRIE etching techniques are used to create a suspended endplate electrode structure with larger vacuum gaps for operation at higher voltages; high density hexagonal oriented ion traps are designed and selective metallization is used to reduce the overlapping area of the electrodes. To avoid surface charging of the dielectric surface that is exposed to ions, Atomic Layer Deposition (ALD) was investigated to deposit highly resistive (ZnO) layer on the dielectric surface to dissipate charge, while adding minimum to the capacitance. Flip-chip bonding was used to bond the ring-electrode and endplate electrodes together using the dedicated alignment mark to minimize the misalignment between the two substrates. With these considerations, both the resolution specificity and sensitivity are expected to improve.

Power/Energy Cost Estimation for Database Management System in Large Database Center

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Keywords: Power Dissipation, Energy Conservation, Operation Modeling, Feedback Loop, Run-time Online Control

In today's large-scale data centers, energy costs (i.e., the electricity bill) are projected to outgrow that of hardware. Despite a long history of research in energy-saving techniques, especially low-power hardware, little work has been done to improve the power efficiency of data management software. Power-aware computing research at the application level has been found to be synergistic to that at the hardware and OS levels because it can provide more opportunities for energy reduction in the underlying systems. This paper describes the author's thesis work on creating a power-aware database management (P-DBMS) and initial ideas on the design of such systems, with the focus on a power-aware query optimization module inside the DBMS. We discuss the main technical challenges in designing the optimizer and present our strategies to meet such challenges. We focus our discussions on a power model to accurately measure the energy costs of query executions plans, and a cost evaluation model for plan selection. An important feature of this work is the formal control-theoretic methods we use to model and optimize the database towards the performance and energy saving goals. This rigorous design methodology is in sharp contrast to heuristic-based adaptive solutions that rely on extensive empirical evaluation and manual tuning. Our experiments using a power-aware query optimizer under our initial design show that there exist significant potential in power/energy savings.

On Active/Reactive Power Modulation of DFIG-based Wind Generation for Inter-area Oscillation Damping

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Keywords: Doubly fed Induction generator (DFIG), Interarea Oscillation Damping, Power System Stabilizer (PSS), Wind Generation

Two different modulation methods of DFIG-based wind generation are compared for inter-area oscillation damping, namely, active power modulation and reactive power modulation. One major concern of active power modulation is its interaction with wind turbine's torsional dynamics. The paper successfully demonstrates the interaction between active power modulation and torsional dynamics and the absence of such interaction in the case of reactive power modulation.

Robust Unit Commitment Problem with Wind Energy and Price Responsive Demand

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Keywords: Unit commitment, Price responsive demand, Benders decomposition, Robust optimization, Cutting plane

On the demand side of power markets, price response, which allows customers to curtail or shift power consumption according to fluctuating prices at different time periods, is emerging in the US recently. More and more experiment reports in various states are showing its effectiveness, such as reducing peak time load, benefiting ratepayers, and increasing the usage of wind energy. However, few of the reports provide analytical results and there is no previous research about combining price responsive demand with unit commitment in power systems.

On the supply side of power systems, how to incorporate wind energy into power grid system is a challenging task because wind energy output is very intermittent and uncertain. In order to characterize its randomness, stochastic programming has been widely used by assuming wind output levels and related probabilities. However, this kind of assumption is not realistic because in most cases it is difficult to know the probability information.

In our project, the price response and wind supply are integrated into classical day-ahead unit commitment system, resulting in an NP-hard multi-stage robust programming problem. The wind output uncertainty is described as polyhedrons. To the best of our knowledge, our work is the first to apply robust optimization to unit commitment problem with price response and renewal energy. Important properties of the optimal solutions are mathematically proved, and non-trivial cutting planes are generated to solve this problem. The proposed algorithm is theoretically superior to Benders or generalized Benders decomposition method. And computational results will also be presented to show that our algorithms are thousands of times faster than those traditional methods or CPLEX solvers.

A System Dynamics Approach to Integrated Regional Water and Energy Management

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Keywords: System dynamics, Water supply and demand, Energy supply and demand, Water quality, GHGs emissions

Rapid growing population and associated socio-economic development are posing challenges on the regional resources management, water and energy in particular. The management of water and energy is separate though they are intertwined. The integrated management involves interconnected cause-and-effect chains and calls for a system view. System dynamics modeling is employed in this study due to its strength in simulating interconnections among different components within a system, capturing the structure of a system, and explaining the behavior that the system produces. This poster proposed a method to develop a system dynamics model for integrated regional water and energy management. This integrated model presents water as a constraint of energy supply as well as a main energy user; similarly, energy is also a constraint of water supply as well as a main water user. The water supply and demand are analyzed by considering both water quality and quantity from different water supply sources and sectoral water withdrawals. The manners of energy supply and demand are captured by analyzing both the thermal values and greenhouse gas emissions of different types of energy during the energy generation and sectoral demand. The preliminary research focused on the demand side. The results estimated the future potential water and energy demand and showed a strong dynamic relationship between water and energy consumption. In the future study, both water supply-demand and energy supply-demand will be linked together and a spatial dimensional will be incorporated in the integrated model. This integrated model and its simulation results will be used as a decision-making tool for water and energy management organizations based on the change of the water and energy stock as well as the associated environmental impacts.

Research Category # 2: ***Materials Science, MEMS/NEMS, Nanotechnology, Biomedical, and Health***

Bio-compatible Material for Implantable RF Antenna

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Keywords: Silicon carbide, RF antenna, Chemical vapor deposition, Biocompatible, Implantable

Silicon carbide (SiC) is one of the few semiconducting materials that combine biocompatibility and great sensing potentiality. SiC chemical inertness, superior tribological properties, and well known hemocompatibility, make it a very promising candidate for *in-vitro* and *in-vivo* biosensors, biologically interfaced neural networks and intelligent implantable medical devices.

Chemical Vapor Deposition (CVD) is the primary technique to produce this high quality material with reasonable deposition rates. Hot wall horizontal CVD reactors are widely used for commercial purposes. One of the benefits of SiC growth via hot-wall CVD is the high temperature processing flexibility with different mechanical components where flow rates and other parameters are adjusted. High quality 4H-SiC epitaxial film can be grown, where growth rate is approximately 32 µm/h. This CVD process is ideal for making antenna structures on semi-insulating substrates which would be needed to create an all-SiC, and therefore completely bio-compatible, sensor for health care monitoring and some other bio-medical applications. To get a heavily doped antenna region, ion implantation has been applied on SiC material. Upon completion of the implantation, a SiC RF antenna is fabricated. The theoretical and experimental performance of the device is then tested.

IREE 2010: Simulation Studies of a Spinal MRI Coil

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Keywords: MRI, Coil Design, Spinal Coil, HFSS

This poster presents a theoretical approach to increasing the signal to noise ratio for a saddle type spinal coil for use within MRI systems. MATLAB as well as Ansoft High Frequency Simulation Software (HFSS) were used to calculate the magnitude of the magnetic field at varying distances from middle of the coil and depict the orientation of the magnetic field vectors. The approach was developed using Time Medical's facilities and expertise in coil design along with the student's prior simulation experience to demonstrate the radiation pattern of various coil designs.

Metal-Insulator-Metal Trench-Refilled Capacitors for On-Chip Energy Storage

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Keywords: Supercapacitor, Dielectric materials, Atomic layer deposition

The impending energy crisis spurs development of advanced on-chip energy storage devices that are capable of delivering power and storing energy for applications from portable electronic devices to renewable energy sources. Nanostructured materials are becoming increasingly important for energy storage and supercapacitors or ultracapacitors are serving as the basis for the next energy systems. . In this work, nanolaminates consisting of Al_2O_3 and TiO_2 were employed by an array of multi-layered metal-insulator-metal (MIM) structures. The MIM structures are fabricated within a high aspect ratio template using atomic layer deposition (ALD). The ability to deposit a conformal and ultrathin layer on high aspect ratio structures is one of the most desirable characteristics of ALD process. High density trench-refilled capacitor array will enlarge the surface area to enhance the capacitance per unit area and provide a solution for monolithic integration with IC's while using the minimum real state in terms of chip area. Recent advances in ALD-enabled trench-refilled capacitor showed an increment in the capacitance per unit planar area of 10 $uFcm^{-2}$ and 100 $uFcm^{-2}$, significantly exceeding previously reported values for metal–insulator–metal capacitors in porous templates. By means of C-V and I-V measurements, the electrical properties, such as permittivity and leakage current, of different ALD dielectrics and nanolaminates have been explored. Ongoing work focuses on development of high-k dielectric materials like Al_2O_3 and HfO_2 with dielectric constants approximately 7 and 25, respectively.

CHARMMing

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Keywords: CHARMMing, Molecular dynamics, Energy minimalization, Density functional theory, Structure analysis, Simulation

CHARMMing is an open source web based graphical interface that allows remote access to a macromolecular simulation program CHARMM. CHARMMing incorporates tasks such as molecular structure analysis, energy minimization, molecular dynamics and other techniques commonly used by computational scientists. CHARMMing even has the capability to generate residue topology files (GENRTF) from undefined atoms and bonds not currently defined by CHARMM.

Further integration of tools will allow extending the capability of not only modeling biomolecular simulations but also include multiscale simulations and density functional theory calculations. Computational multiscale modeling of materials and chemical interactions will provide seamless interaction of different spatial scales of data. CHARMMing even incorporates the ability to simulate coarse grain models of functional groups to allow saving time and computing power and also allow fairly accurate simulations.

Design / Fabrication of an Implantable MEMS Sensor

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Keywords: Hydro-gel, Silicon Carbide, LC resonator circuit, Implantable, Sensor

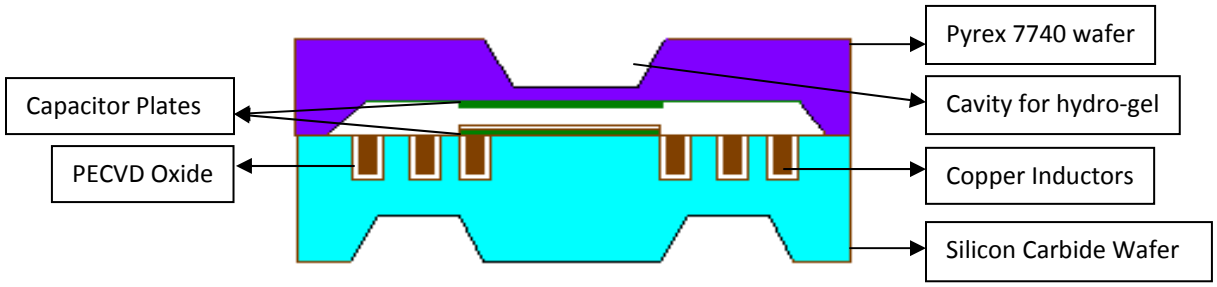
The primary goal of the research is to design and fabricate a MEMS based sensor which uses hydro-gel, silicon carbide and LC circuit for wireless detection. This idea can be used for harsh environments, implantable systems and regions where physical access to the sensor is not possible.

Hydro-gel is novel polymer that is attracting the attention of all the MEMS engineers. Hydro-gels are hydrophilic polymeric networks and some have the capability of absorbing large quantities of water. One property of hydro-gel is to swell when it reacts chemically with physical parameters, in turn, converting chemical energy into mechanical energy. This property makes hydro-gel a very useful material for sensors. Hydro-gels are sensitive to many physical factors such as temperature, pH, concentration of organic compounds in water and salt concentration.

Silicon Carbide is the advanced MEMS material which is known for its mechanical strength, corrosion resistance, electrical and thermal performance and bio-compatibility. The above properties of silicon carbide make it well suited for harsh environments and in implantable systems.

An **LC resonator,** powered externally, is used to operate the sensor remotely, addressing the great need for wireless operation in sensors. The physical parameter, (cholesterol, glucose, etc.) that needs to be detected, reacts with the hydro-gel and begins the swelling process. As the hydro-gel swells the upper plate of a capacitor is deflected, thus changing the response in an LC resonator. The resulting change in resonating frequency can be remotely detected by plotting the reflected impedance.

SENSOR MODEL:



Design, Simulation and Fabrication of a Miniature Electron Spectrometer for Chemical Analysis of Thin Films

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Keywords: Computer Aided Design (CAD), Cylindrical Mirror Analyzer (CMA), Auger Electron Spectroscopy (AES), Field Emission, Thin Film, Finite Element Modeling (FEM), Ultra High Vacuum (UHV), Focused Ion Beam (FIB), Nanotechnology, Surface Analysis, Electron Spectroscopy

The Cylindrical Mirror Analyzer (CMA) is a standard tool used to perform Auger Electron Spectroscopy (AES) analysis for elemental composition and nano-scale metrology of materials. The thin films used to manufacture devices such as optical lenses, sensors, solar cells, integrated circuits, LCD displays etc, must be analyzed after the thin films are deposited for quality control purposes. The high cost and large size of commercially available CMAs has limited their use in routine industrial testing and prototyping, particularly in smaller businesses. This poster will present results from a miniature CMA with a field emission electron source which has been designed to be a compact and portable AES system for chemical analysis of thin films. The miniature CMA is small enough to mount on a standard 2 ¾" Ultra High Vacuum (UHV) Conflat flange. The CMA is essentially a cylindrical capacitor for which electrostatic field and electron flight simulations were performed by solving the Poisson equation using the Finite Element Method (FEM). Two simulation software packages were used: SIMION and COMSOL. COMSOL was chosen as the final research platform for modeling the spectrometer designs. COMSOL is a multiphysics engineering, design, and finite element analysis software environment for the modeling and simulation of any physics-based system. COMSOL also has superior built in options for custom meshing, outstanding post processing, and a graphical user interface for Computer Aided Design (CAD) and solution visualization. The COMSOL model was verified by using simple parallel plate and cylindrical capacitor models for which the electron trajectory can be solved analytically. The CMA problem was then solved in 2D and in 3D to allow for a 3 dimensional visualization of the trajectory of the electrons through the spectrometer.

The final poster will also show different design configurations and preliminary results for the proposed CMA including different proposed electron emitter excitation sources. Preliminary results will be shown on the fabrication of a field emission tip that has been machined on a 25 micron gold wire with approximately 500 square micron area using Focused Ion Beam (FIB) milling. The FIB is located at the University of South Florida (USF) College of Engineering in the Nanotechnology Research and Education Center (NREC).

Design and Prototyping of a Micro-Turbine

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Keywords: Micro-turbine, Impulse micro-turbine, Physiological system, Motion, Pressure

This paper presents the design, prototyping and assembly of a micro-turbine. An impulse micro-turbine, which can be integrated onto smaller devices, is presented. Theoretical calculation shows that the micro-turbine provides high number of revolutions making them particularly valuable for medical applications, for instance, in micro surgery tools that require reasonably high forces or high speed. The design of a conventional turbine has been scaled and adjusted to reduce the friction between the rotor and the case in order to avoid the loss of rotational speed. To examine the flow behavior inside of the turbine, and to determine if all the conditions are given for the turbine to rotate, a succession of simulations using ANSYS FLUENT Flow Modeling Software were performed.

To produce an elevated torque and to make sure medical applicability, the turbine design is developed and calculated with water parameters, the dimensions are on the range of 20 millimeters, which make the turbines viable for micro surgery tools. The turbine is designed assuming a constant pressure turbine, a low head and a constant flow to work. Furthermore, there are medical conditions that require the replacement of some living parts, such as pumps and valves to regulate fluids in the human body. In this scenario, this paper presents the design of a micro-turbine that can be an element used in a physiological system, where flux or motion and pressure are the principal parameters of the model. It also contributes to the academic and practical discussion about the development of micro medical tools, alternative energy sources, and micro environment applications. Nevertheless, the development and implementation of this research seeks to meet critical challenges for the healthcare, environmental and military arenas.

Dual Responsive Actuation through Poly (N-isopropylacrylamide) Fe_3O_4 Nanocomposites

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Keywords: Magnetic Nanoparticles, Thermoresponsive Polymer, AC Magnetic Field

Magnetic particles of micrometer and nanometer scale are being used in a number of medical applications. Our goal is to develop a system that may be used for micro or nano actuation for biomedical applications. This will be accomplished by the use of a stimuli responsive polymer with embedded Fe_3O_4 nanoparticles to build actuators that are dual responsive. These nanoparticles will be evenly dispersed in poly(N-isopropylacrylamide) (PNIPAAm), a thermally-responsive polymer. When the responsive polymer is triggered by the stimulus, it displays an abrupt change in its physical-chemical properties. In our approach, change in ambient temperature or temperature of the PNIPAAm itself will induce a physical volumetric change. Particularly, an externally applied AC magnetic field can excite the embedded nanoparticles to heat up, and the resultant temperature increase above the lower critical solution temperature (LCST) of 32°C will cause the responsive polymer to collapse from its swollen state. Once the magnetic field is removed, the responsive polymer will return to its normal swollen state.

Up to this point we have made significant progress in the development of the responsive polymer nanocomposites based on PNIPAAm. With the use of electron beam lithography we generated various structure patterns on the polymer layer. This was followed by adding water with a temperature above 32°C to the structure. The change in temperature allowed the swollen structure to collapse. An atomic force microscope (AFM) was used to measure the height difference before and after the addition of the warm water. The results showed that the structure at rest had a height of 102.37 nm, and after warm water exposure, the structure collapsed by about 50% to a height of 54.05 nm. Recently, progress has been made in the area of synthesis of responsive polymer nanocomposites that consist of responsive polymer with embedded Fe_3O_4 magnetic nanoparticles with an average size of 9 nm. These nanoparticles were embedded in PNIPAAm and we were able to obtain a uniform dispersion without noticeable clustering. The next phase of the project is to develop a magnetic heating station, where the magnetic nanoparticles can receive an external AC magnetic field that is able to remotely generate heat. The particles will transform the energy from the magnetic field into heat as a result of the hysteresis loss, eddy current, Brownian relaxation, and Neel relaxation.

The technology used in this system could spread to other areas of biomedical technologies. One of the areas that will benefit from this technology is the area of drug delivery. If the structures are made into miniature enclosures that contain a specific drug, the enclosed medication may be released at a precise location when the stimulus is supplied at the area of target. This will greatly minimize the issue of side effects and produced damage to other areas of the body.

Fabrication and Modeling of Organic Dielectric Tunnel Diodes

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Keywords: Rectenna, Tunnel diode, SAM, Self-assembly, Alkanethiol, Energy Harvesting

In this study, a permanent tunnel diode structure incorporating an organic dielectric is fabricated for the application of direct electromagnetic rectification. Fabrication of the diode was carried out by first preparing a low roughness Au film on an oxidized Si substrate. This Gold layer was patterned and etched defining contact pads and bottom metal regions for tunnel junction. Photo resist masked the assembly of alkanethiol film which was carried out by immersion in a millimolar solution of 1-Dodecanethiol in ethanol. A top metal of Cr was slowly e-beam evaporated and then lifted off to form the top metal for the junctions and additional contact pads. (Figure 1)

The finished devices were immediately DC tested to give the current-voltage characteristics. Because of the presence of a dipole within the self-assembled film, work function modification resulted in a symmetric diode response. The tunneling performance was fitted with the Simmons Model in an effort to refine the actual barrier heights and contact area. Organic film thickness was measured by impedance spectroscopy and determined to be in good agreement with the computer modeled thickness at 1.54 nm. Atomic force microscopy was used to determine roughness metal films and qualitative presence of the organic film on Gold. The fully saturated terminations of the self-assembled film result in a smoothening effect as small imperfections and gold lattice steps are masked.

The intent of using the self-assembled film as opposed to a metallic oxide as a barrier is cost reduction. The end application of this device is a high speed rectifier in a rectenna for energy harvesting applications. When placed in an array, the rectennas can be used to harvest waste micron-wavelength heat from solar energy systems. Additionally, these same rectennas can be used as IR sensors if appropriately scaled. Future work includes experimentation with additional self-assembled species of both different length and termination chemistry. Additionally, improving yield is essential to the creation of a large functioning array. Limitations and intrinsic failure causes are explored in addition to solutions offered.

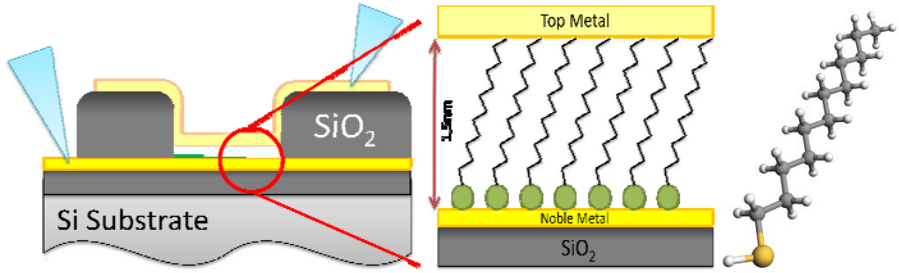

Fig. 1. (a) Structure overview showing probe points; (b) Metal-Insulator-Metal tunnel junction from left; (c) Ball-Stick model of 1-Dodecanethiol

2.45 GHz Low Profile End-Loaded Dipole Backed by a High Impedance Surface

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Keywords: Dipole antennas, Broadband antennas, Tunable antennas, Electromagnetic bandgap, Frequency selective surface.

Herein a low-profile planar antenna operating at 2.45 GHz with uni-directional radiation is presented. The goal of this effort was to establish a baseline approach for realizing a flexible antenna with moderate bandwidth that can be used in applications such as body-worn sensors. For electromagnetic sensing, e.g. in the case of radiometric sensors, reduction in backside radiation is important in order to maximize the detection sensitivity.

Accordingly, a design incorporating a backing ground-plane is appropriate. Furthermore, in this particular effort, the ability to tune the operating frequency is desirable as this allows real-time adjustment of the sensing depth. For this reason, the architecture has been conceived with the aim of facilitating eventual integration of varactor-based tuning. The radiator selected for this design corresponds to a broadband dipole, the end loaded planar open sleeve dipole (ELPOSD). The ELPOSD consists of a printed dipole with two parasitic elements (sleeves) along its sides and capacitive loading at the end. This antenna is fed from beneath the ground plane by live vias connected to a microstrip to coplanar strip balun. The EBG structure is based on the Jerusalem Cross geometry and is sandwiched between two 1.27 mm-thick substrate layers, resulting in a total antenna thickness (excluding the feed layer) of ~$\lambda/50$. Measured performance of the antenna demonstrates a bandwidth of 30 MHz at 2.45 GHz, with a gain of ~3.5 dB.

Thin-Film Bulk Acoustic MEMS Resonators Enabled Low Loss High-*Q* On-Chip Filter Arrays

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Keywords: Microelectromechanical systems (MEMS) Resonators, Piezoelectric resonators, Radio-frequency (RF) MEMS

Over the past decade, a great deal of research effort has been devoted to development of low-power and high-*Q* micromechanical resonators with a high quality factor (*Q*) suitable for bring the frequency reference and signal processing functionalities, such as oscillators, mixers and frond-end filters at higher frequency bands (e.g., UHF and beyond), on to a single chip. Currently, devices based on mechanical vibration such as quartz crystals and surface acoustic wave (SAW) are widely used to implement high-*Q* oscillators and band-pass filters in communications transceivers. Unfortunately, despite of the beneficial high *Q* offered by quartz crystal and SAW devices, they are off-chip components that must be integrated with electronics at the board level, thus hindering the ultimate miniaturization and portability of wireless transceivers. Very promising alternatives to overcome the issue with the off-chip devices have been demonstrated by on-chip micromechanical resonators with electrostatic and piezoelectric transduction mechanisms along with small form factor, high quality factor (*Q*'s >10,000) and low insertion loss.

The objective for the present project is design and fabricate piezoelectrically transuded mechanical filters in the frequency range from 1 GHz to 12 GHz (L, S, C, and X band) with 5% bandwidth and insertion loss less than 2dB. One of the most viable on-chip alternatives to fulfill the aforementioned specifications is the thin-film bulk acoustic resonators (FBAR). Even though the FBAR technologies seem to reach a phase of maturity and have been produced in large volumes through industrial manufacturing processes for applications that is less performance demanding such as RF front-end duplexer, there is still a lot of room for improvement in terms spurious modes, relatively poor quality factor, relatively high temperature coefficient, limited frequency tuning range and the level of feedthrough noises. Therefore, there is still more research work that can be done on the optimization of the FBAR technology. The primary goal for this project will be focused on addressing all the drawbacks for the traditional FBAR devices mentioned above while jointly investigating new fabrications process such as molding process based chemical mechanical polishing (CMP) and deep reactive etching (DRIE) to further simplify the microfabrication and the overall performance of on-chip RF filters based on FBAR technology.

A Novel Microcontact Printing Platform to Pattern Substrates with Low Fill Factor Stamps

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Keywords: Microcontact printing, Self-assembled monolayer, Fill factor

Microcontact printing (μCP) is a technique to pattern well defined surface geometries on substrates by forming self-assembled monolayer (SAM) domains. This is achieved by transferring 'ink' molecules (usually alkanethiols or alkyl silanes) adsorbed on a polymer stamp by conformal contact of micron sized features onto a substrate. The feature size and spatial distribution give rise to fill factor (defined as the ratio of the combined lateral area of features to the total stamp area) and plays an important role in establishing the stamp stability criteria. A predominant stability problem in low fill factor stamps is the 'roof' collapse when the base plane (unwanted contact region) of the stamp contacts the substrate. If the stability of the roof of the stamp is compromised at a particular point, then the work of adhesion overcomes the restoring force of the features due to low fill factor and the roof collapse propagates until the entire stamp collapses.

Therefore, we hypothesized that introducing large micro-columns at the periphery of the stamp substrate contact area would increase the fill factor, redistribute the contact pressure and prevent the onset and propagation of stamp collapse in the low fill factor stamps. In order to test this hypothesis, we examined the effect of micro column geometry and distribution on elastomeric stamp stability and contact printing feature fidelity in low fill factor and large pattern area scenarios. By circumscribing the microcolumn around the critical region, we were able to support the roof of the stamp spanning over 24000 μm with the height of the column at 2 μm and lateral dimension of 250 μm. This μCP platform was used to faithfully transfer the patterns from PDMS stamps with fill factor as low as 0.28% whereas the transfer wasn't possible without the circumscribed microcolumn. We believe that this μCP could be universally used for micro- and nano-contact printing applications with low fill factors.

Design of a Laminar Flow Reactor Utilizing Plasma Enhanced Atomic Layer Deposition

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Keywords: Atomic layer deposition, Chemical vapor deposition, Nanotechnology, Thin film deposition, Plasma, ALD, CVD

A plasma enhanced atomic layer deposition reactor (PE-ALD) was built for the purpose of growing thin films on wafers up to 2.5" in diameter. Internationally, papers have been published describing characteristics of both homebuilt [1,2,3] and commercially available ALD reactors [4]. The construction of this reactor was strategically designed using these descriptions, within an allowable project time and budget. Design characteristics include an inert carrier gas, millisecond speed precursor valves, remotely generated inductively coupled plasma, and a chamber with a high volume to surface ratio geometry. The reactor will act to complement and increase the current application repertoire versus our commercially available reactor located in the University's thin films laboratory. In this regard, the chamber must be optimized to accommodate unique recipe applications currently unattainable with the in-house system. The functionality of this reactor will include three separate modes of operation: a thermal reaction mode (thermal ALD) for use with general recipe applications, an isolated chamber mode necessary for high aspect ratio substrates, and a plasma enhanced mode (plasma enhanced ALD) for greater process recipe versatility such as metals and nitrides. ALD allows for a precision unattainable with other deposition processes. Unlike CVD, ALD is not dependent upon precursor flux upon the substrate surface, instead relying upon step-wise A + B = P synthesis. Important considerations included an optimized pumping rate and a minimization of unavoidable deposition upon all surfaces other than the process wafer. Process optimization was also pursued by means of vacuum gauge feedback and automation of precursor valve cycle sequence by means of a Lab View enabled PC. Other automated controllable growth parameters include substrate heater temperatures, reactor wall temperatures and the energies of plasma ion bombardment upon the substrate surface species. Safety concerns have also been addressed by ensuring suitable gas exhaust, pump maintenance, hard-wired safety valve shut-off programming and gas cylinder and hazardous materials safety training of individual users. The chamber design, multitude of process optimizations and comparisons with existing designs and models allow for substantial research parameters to be explored and discussed.

Task-Oriented Control of a 9-DoF WMRA System for Opening a Spring-Loaded Door Task

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Keywords: Task-Oriented, Mobile Robot, Manipulator, Redundancy, ADL

A 9-Dof wheelchair mounted robotic arm system (WMRA) has been developed to assist wheelchair-bound persons with upper limb motion limitations to perform activities of daily living (ADL) tasks. In this paper, we utilize mobile manipulation control to keep the end-effector stationary while moving the base and vice versa. This allows easier execution of a group of pre-set ADL tasks including opening and holding a spring loaded door passing through by locking the end-effector position and orientation. Redundancy resolution is achieved by optimizing the manipulability measure while the ADL task is being performed. Combined mobility and manipulation is expanded in this work to turn the USF WMRA into a task oriented robotic system.

Novel Synthesis, Characterization & Applications of Nanodiamond – Conductive Polymer Nanocomposites films

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Keywords: Nanodiamond, Polyaniline, Polythiophene, Corrosion, Photosensor

Functional and composite nanodiamond (ND) are rapidly emerging as promising materials for the next-generation for quantum information processing, electronic material, magnetotometry, novel imaging and IR-fluorescence etc. applications. Nanocomposites of nanodiamond particles with conductive polymers (i.e. polyaniline (PANI) and ragioregular polyhexylthiophene (RRPHTh)) displayed novel properties resulting from the molecular level interaction of diamond with conducting polymer molecules.

Recently, we have synthesized for the first time the NDs-conductive polymer nanocomposites by oxidative polymerization under controlled conditions by varying Nd and aniline monomer ratios. The ND-Polymer nanocomposite films were characterized by UV-Vis, FTIR, electrochemistry, impedance, Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM) and electrical conductivity techniques, respectively. We have been published initial result in *J. Phyc. Chem C*. The electrochemical investigation on ND-PANI revealed the wider potential values with independent redox characteristics of polyaniline and nanodiamond. There is an interaction of the free electron pairs of the nitrogen atoms of the PANI with charged molecules on the surface of ND with PANI system.

The concept of using an active electronic barrier ND-PANI barrier built-in electric field is created at the metal surface. The ND-PANI film shows excellent corrosion inhibitor characteristics for metals (steel and aluminum) due to its chain conformation and electronic properties, as demonstrated in this work. The photoelectrochemical study has revealed photoinduced electron transfer in nanohybrid ragioregular polyhexylthiophene (RRPHTh) with donor and ND as acceptor providing a molecular approach to high-efficiency photoelectrochemical conversion properties. The ND-RRPHTh has shown promising morphological and photoelectrochemical properties than RRPHTh films. The RRPHTh forms crystalline structure with ND nanoparticles followed by diffusion of nanoparticles molecules to nucleation sites to form hexagonal aggregation as evidence from Raman and TEM studies. The photoelectrochemical properties of NDs-RRPHTh deposited on either n-Si or ITO coated glass plate in electrolyte containing tetraethyl ammonium tetrafluoroborate (TBATFB) is around 8 to 10 times higher in current density, and energy conversion efficiencies as compared to RRPHTh films. In the present work, we have investigated photoelectrochemical properties aiming to assemble photovoltaic devices and photosensor based on ND-RRPHTh nanohybrid films.

Characterization of Palladium and Bimetallic Nickel/Palladium Catalyst for use in Methane Steam Reforming

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Keywords: Nanocrystals, Polyol synthesis, X Ray diffraction, Monometallic and bimetallic particles

The increasing need for reliable sources of renewable energy has been a driving force in the development of catalysts, composed of a wide variety of different metals and metal oxides, designed for the production of synthetic fuels. In our studies, we have investigated various properties of Pd and Ni/Pd catalysts synthesized for use methane steam reforming through the one-pot polyol synthesis technique. In one set of experiments, we synthesize size-controlled Pd nanoparticles via a polyol synthesis to study size-related phenomena of methane reforming. The size of Pd nanocrystals is controlled by varying the ratio of Pd precursors used in synthesis. Because the Pd^{2+} nucleates faster than Pd^{4+}, the particles formed using a larger proportion of Pd^{2+} precursor are smaller. In the second set of experiments, we synthesize bimetallic Ni/Pd catalysts and characterize them using X-ray diffraction as a function of time. The monometallic particles formed were found to have sizes ranging from 5.5nm to 25 nm. Our analyses of the bimetallic particles show a much larger average size than seen in the monometallic particles and suggest that the bimetallic particles formed are initially homogeneous alloy particles that undergo atomic diffusion to form core-shell particles with a surface layer of nickel oxide.

Structural and Electrical Studies of Barium Strontium Titanate (BST) Thin Films for Frequency Tunable Device Applications

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Keywords: Barium Strontium Titanate (BST), Tunable microwave applications, RF magnetron sputtering, Sol-gel

Barium Strontium Titanate ($Ba_{1-x}SrxTiO_3$), BST, thin films have proven their forte in frequency tunable devices due to their promising electrical properties related to dielectric loss, power handling, breakdown voltage, capacitance tuning range and component integration[1,2]. On the other hand, the BST components are less volatile as compared to the Pb-based ferroelectric materials, thereby making it relatively easier to introduce into fabrication facilities[3]. BST thin film properties heavily depend on composition, stoichiometry, microstructure (grain size and size distribution), film thickness, characteristics of electrode, and homogeneity of the film[4].

In this work the micro structural and electrical properties of radio frequency (RF) magnetron sputtered BST thin films are investigated and compared with those grown by sol-gel method. The crystal structure of the films has been analyzed using X-Ray diffraction (XRD) and Infrared spectroscopy (FTIR). Non-contact corona-kelvin based metrology is employed to calculate key parameters such as dielectric effective oxide thickness (EOT), dielectric voltage in valence band tunneling range (*VB*), interface trapped charge (*Qit*) and flatband voltage on a variety of substrates and films resulting from varying film formation processes.

Fabrication and Testing of 'I-beam' Microneedles for Drug Delivery and Biofluid Extraction

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Keywords: Microneedles; DRIE; Microfluidics; Lab-on-a-Chip; Bio-MEMS

This research aims to validate the effect of geometrical variations on the fracture strength of hollow silicon microneedles. Needle failure due to axial and shear loads may be due to heterogeneous peak stresses within the bulk material. Analytical determination of physical usage limits of microneedles can be misleading, as beam fracture models do not translate well to the micro-scale. Needle failure due to breakage can generally attributed to shear forces. In the study, 35 and 36 gauge hollow microneedles with a conventional circular lumen and those with enhanced 'letter I' shaped lumen geometry were fabricated. Due to their geometry, the 'I' shaped needles have a higher second moment of inertia, which leads to higher strength. The fracture limits of these needles due to shear forces were quantified. Average shear fracture limits of 36 gauge needles was 36.51 gf for circular geometry, while for the 'I' shaped needles it was 96.64 gf along the lateral direction. For 35 gauge needles the average fracture limits were 79.9 gf for circular needles, and 148.65 gf along the lateral direction for the enhanced geometry needles. Along the weaker axis, the enhanced geometry resulted in marginally lower strength than the circular counterparts for the 35 gauge needles, while it appreciably increased for the 36 gauge needles. The effect of geometry on shear strength was significantly higher for smaller microneedles.

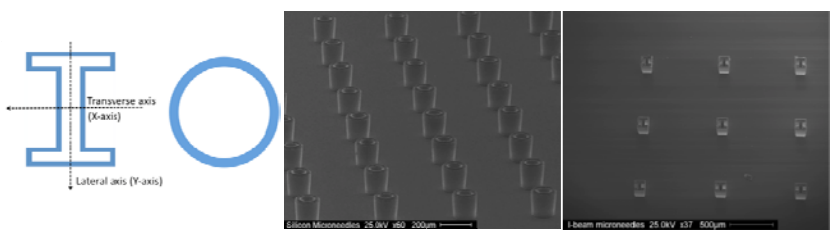

Fig. 1. (a) Cross-section of fabricated microneedles (b) SEM image of circular shaped needles (c) SEM image of 'I-beam' shaped needles

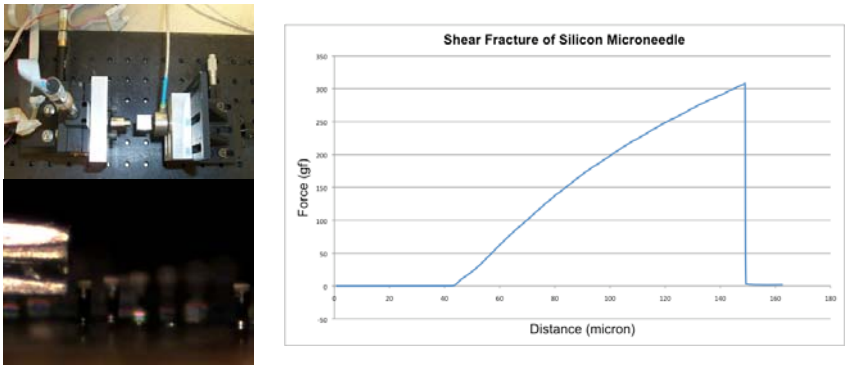

Fig. 2. (a) Microneedle testing setup using a force measurement load cell and motorized

Arbitrary Actuation of Bidirectional Electrowetting

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Keywords: Electrowetting, Surface Energy, Diode, Valve Metals

In the electrowetting process, a quasi-stable condition is obtained by placing a droplet on top of a metallic substrate (aluminum) coated by a hydrophobic dielectric layer (Cytop). Then, this condition is disturbed by changing the electrical potential of the substrate, upon which surface energy of Cytop rises. A part of this energy surge is offset by the wetting of Cytop with the droplet, resulting in a decrease of wetting angle. If the potential across the dielectric layer on two coplanar electrodes differs in magnitude, electrowetting actuation could be observed, where the wetting angle on one substrate is different from that on the other side and the ultimate result of this asymmetry is the movement of the droplet towards one side. Here, it is described how one could carry out bidirectional electrowetting actuation using differences in charge transfer for positive and negative potentials. The results of some tests illustrating the desired behavior are presented.

Design of a Ternary Barrel Shifter Using Multiple-Valued Reversible Logic

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Keywords: Modified Fredkin Gate; Quantum cost, Ancilla bits, Quantum computing

Multiple-valued reversible logic is emerging as a promising computing paradigm as it helps in reducing the width of the reversible or quantum circuits. Further, a barrel shifter that can shift and rotate multiple bits in a single cycle forms the essence of many computing systems. In this paper, we propose an efficient architecture and design of a reversible ternary barrel shifter. The ternary barrel shifter is realized using the Modified Fredkin gates (MFG) and the ternary Feynman gates. The design is evaluated in terms of quantum cost, the number of garbage outputs and the number of ancilla bits. To our knowledge, the use of multiple valued reversible logic for the design of a barrel shifter is being attempted for the first time in the literature.

Structure and Opto-Electrochemical properties of ZnO rods grown on *n*-type Si substrate

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Keywords: ZnO, Nanorods

Zinc oxide (ZnO) is an II-VI semiconductor with a wide direct band gap of 3.37 eV at 300 K and large exciton binding energy (60 meV). It has attracted great attention as a promising functional material with unique properties for applications in UV light emitters transparency, electrochromic, field emissions, biosensors, field effect transistors, optical, and solar cells. ZnO nanorods have been synthesized on an *n*-type Si substrate using conventional hydrothermal method with surfactant added as the modifying and protecting agent. The surface morphology, electrochemical, and opto-electrochemical properties of ZnO nanorods are investigated by using scanning electron microscopy (SEM), X-Ray diffraction spectroscopy (XRD), energy dispersive X-ray spectroscopy (EDS), cyclic voltammetry, impedance spectroscopy techniques. Easy and cost-effective method for uniform growth of vertically aligned ZnO nanorods with controlled morphology is suggested in this work. Our work shows the mechanisms to control nanorods shape and size through initial seeding and surfactant agent. It is now established that crystallinity, particle size, and morphology play significant roles in the electrochemical performance of ZnO electrode. The electrochemical studies in various electrolytes show the cycling characteristics and rate capability of ZnO nanorods. We have observed photo response in both visible and UV light which could be exploited for future photosensor applications.

Novel Method for Droplet Transport by Continuous Electrowetting on Dielectric

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Keywords: Electrowetting, Lab-on-a-Chip, Valve Metal

Electrowetting on dielectric (EWOD) is a process in which the apparent surface energy, and thereby the apparent contact angle, of a fluid droplet resting on a layered substrate comprising an electrode and separating dielectric layer is reduced by the application of an electric field. If an electric field is applied to the droplet asymmetrically, the imbalance in wetting creates a net force that propels the droplet across the substrate. The ability of EWOD to control the motion of microliter scale fluid droplets has applications in a wide range of microfluidic devices: lab-on-a-chip devices, adjustable optics, digital displays, etc. Current approaches to droplet transport via EWOD utilize complex arrays of individual electrodes to induce the asymmetric contact angle reduction needed for motion. This results in droplet motion in discrete steps (with a magnitude equivalent to electrode size) by 'handing off' of the droplet from electrode to electrode in sequence, necessitating complex control systems. In this poster we characterize the diode-like behavior of thin aluminum films and present a novel method for continuous droplet transport via EWOD utilizing the current rectifying properties of valve metals. We have demonstrated that continuous droplet motion can be achieved by applying a DC voltage across a simple circuit consisting of a single electrode, a dielectric layer and a pattern of aluminum 'diode' sites and that the direction of motion can be controlled by adjusting the polarity of the applied voltage.

Non-Pharmaceutical Interventions (NPI) for the Mitigation of Pandemic Influenza

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Keywords: Pandemic influenza, Simulation, Non-pharmaceutical mitigation strategies

In the event of an influenza pandemic, non-pharmaceutical interventions (NPI), such as social distancing, will likely be the only effective containment measure available in the early phase of the pandemic. In this research, we examine various NPI strategies, such as quarantine of isolated cases, household quarantine, school and workplace closures, and study their effect on the infection attack rate and the societal and economic cost of the pandemic.

Novel Magneto-Dielectric Polymer Nanocomposite for Miniaturization and Bandwidth Improvement of Microwave Antennas

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Keywords: Bandwidth, Gain, magneto-dielectric, Microstrip antennas, Nanocomposites, Permeability, Permittivity, Wave impedance

In this work, magneto-dielectric polymer nanocomposites are investigated as a new class of functional materials well-suited for the miniaturization and bandwidth improvement of microwave Antennas. Magnetite (Fe_3O_4) nanoparticles are homogeneously dispersed in a polymer matrix which exhibits low losses at microwave frequencies. The monodispersion of the magnetic nanoparticles, with sub-10 nm diameters and tight size distribution, enhances the microwave properties of the engineered composite material by increasing the relative permeability and relative permittivity

As a demonstration of the novelty and usefulness of this material, the prototype of a multilayer microstrip patch antenna is presented. Substantial improvements in the bandwidth, size and wave impedance of the antenna were obtained by means of the magneto-dielectric properties of polymer nanocomposites. Additionally, ease of manufacturing and low cost are combined to make this polymeric material well-suited for the engineering of substrates and laminates for miniaturized and performance-improved antenna applications.

Electrospinning Protein Nanofibers to Control Cell Adhesion

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Keywords: Electrospinning, Integrins, focal adhesion, globular protein, fibronectin

The structural and mechanical properties of a surface often play an integral part in the determination of the cell adhesion strength and design parameters for creating a biodegradable electrospun scaffold. This electrospun protein scaffold serves as an extracellular matrix to which adhesion interaction exist with cells via cell surface integrins. This interaction is vital in regulation cell differentiation, growth and migration.

Nanofibers composed of the globular proteins bovine serum albumin (BSA) and fibronectin were produced by electrospinning from a solution consisting of 10% BSA, β-mercaptoethanol, trifluoroethanol (TFE), deionized water $(dH_2O)_2$, and various concentrations of fibronectin. Fibers based on BSA were selected due to its abundance in blood and its non-adhesive nature. Therefore, the nanofibers produced via the spinning process are expected to resist protein fouling and non-specific adhesion. The incorporation of fibronectin is expected to support integrin receptor-mediated cell adhesion, would not be considered foreign and be rejected by the body when used for biomedical applications.

We will demonstrate the ability to manipulate ligand receptor interaction, the properties of the electrospun fibers, the concentration of the fibronectin which when viewed during immunofluorescence analysis should show the specific binding site to which integrins can bind and finally control and the formation of focal adhesions sites in cells cultured on the fibers. Fibronectin serves to organize cellular interaction with the extracellular matrix by binding to the different components found in it and the membrane bound fibronectin receptors on cell surfaces, thus mediating cellular adhesion.

In this study, we embraced a biomedical engineering approach to assess the role of fibronectin polymerization on the varying physical and mechanical properties, adhesion strength and its support for $\alpha_5\beta_1$ integrin binding and signaling. We will analyze the role that the cell adhesion protein fibronectin plays when embedded with electrospun fibrous mats, its advantageous properties with respect to focal adhesion, integrin binding and cell interaction with the ECM versus that of an electrospun fiber without the integration of fibronectin.

Cellular Interactions on Epitaxial Graphene on Sic (0001) Substrates

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Keywords: Biocompatibilty, Cell viability, Epitaxial graphene, SiC

Biosensors and implantable devices are increasingly becoming a part of everyday life. The materials used in biosensors or implantable biomedical devices, must be compatible with biological matter to be ultimately used for *in vivo* applications [1]. In this regard, carbon-based materials have proven to be promising candidates as they combine good biocompatibility with excellent chemical resistance [2]. Graphene, well known for its exceptional electrical, thermal and mechanical properties [3], as well as for its high sensitivity to chemical environments [4], is an appealing candidate for biomedical applications but only once its biocompatibility has been assessed.

In this work we present an initial assessment of the biocompatibility of epitaxial graphene on 6H-SiC (0001). We have analyzed the interaction of HaCaT (human keratinocyte) cells on epitaxial graphene and compared it with that of bare 6H-SiC (0001) while using polystyrene (PSt) as the control surface, by using fluorescent optical microscopy, MTT assays and atomic force microscopy (AFM).

The graphene monolayer films were grown under a 900 mbar Ar environment at an annealing temperature of 1650°C [5]. Subsequently, they were characterized by AFM, XPS and ARPES. Previous to cell seeding, the graphene surfaces were cleaned of possible air contamination by thermal annealing under an Ar atmosphere at 700°C while the 6H-SiC surfaces were chemically cleaned as described in [6].

For both graphene and 6H-SiC the morphology of the HaCaT cells was similar to that on the PSt control with signs of cell-cell interaction and cell-substrate interaction. The MTT assay results showed viability results comparable for both substrates. These preliminary results suggest that, similarly to SiC [6], graphene may be a biocompatible material suitable for implantable applications once *in vivo* studies have been completed.

A MEMS Ultrasonic Sensor Design for Early Ovarian Cancer Detection

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Keywords: Ovarian Cancer, MEMS, CMUT, ultrasound, transducer

In this study, we investigate the feasibility of designing a simple, disposable, low cost, ultra sensitive, fully-integrated biosensor chip for early ovarian cancer detection including Stage I and II patients. The proposed sensor quantifies urinary anti-apoptotic protein Bcl-2 level that is elevated at difference stages of ovarian cancer. Detection of early stage ovarian cancer is associated with high survival (>95%) and reduced lifelong medical costs, but currently accounts for less than 10% of diagnosed ovarian cancer cases. Our approach includes MEMS ultrasonic transducers that have been demonstrated to be advantageous as compared to piezoelectric transducers. Piezoelectric transducers lack sensitivity for detection of early ovarian cancer, are expensive, not biocompatible, cannot be integrated for a fully-packaged chip. Our sensor detects the frequency shift due to mass loading change generated by Bcl-2 adhesion to antibodies on the sensor surface. In this paper, we will present our design and fabrication efforts. Our experimentally verified FEM simulations indicate 0.15 pg/ml sensitivity with our sensor. The simulations are currently being validated by current state of the art ovarian cancer detection tests and methods.

Nanomanufacturability of Thin Film MIM Tunnel Junctions

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Keywords: MIM diodes, Rectenna, Dielectrics, Tunnel junctions, Spacer, Stepped, Lithography, Materials Characterization, MEMS/NEMS

Ni/NiO/Cr MIM tunnel junctions with various structures were fabricated. Their dc electrical responses were analyzed to identify the effects of diode design on asymmetry and emission current. It was found that the stepped structure with an oxide spacer prevented shorting at the step thus circumventing premature breakdown as exhibited by the other structures. It also demonstrated better asymmetry and a high enough emission current alleviating the issues caused by the other structures. It was observed that the current density of the self aligned stepped structure showed less variance across devices than the stepped spacer structure. On the other hand, the resistance of the same structure showed to be more ohmic in nature when compared to the stepped structure with spacer.

Figure 1 Different design structures fabricated for analysis of working of MIM tunnel junctions.

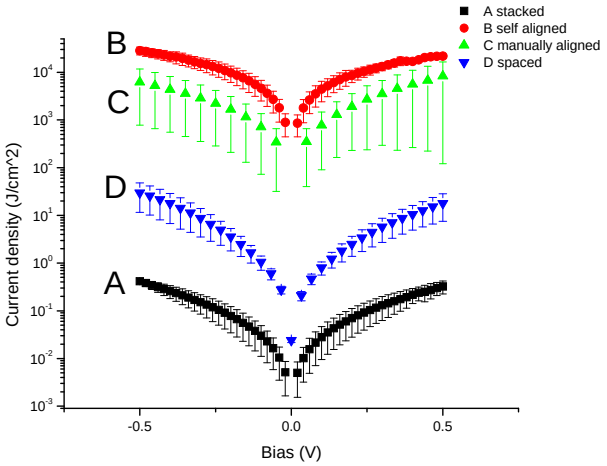

Figure 2 Tafel plots of current densities from the various designs

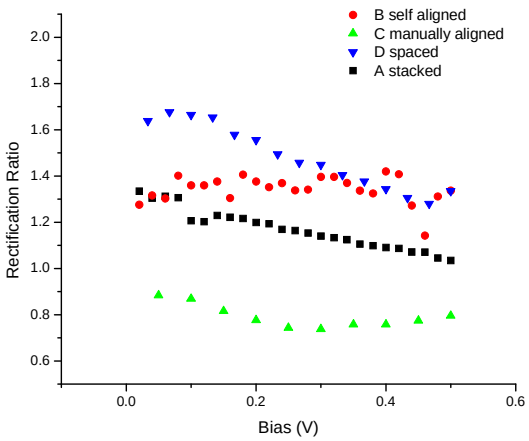

Figure 3 Rectification Ratios of the various designs

Modeling Electrokinetics of Gene Delivery

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Keywords: Drug and Gene Delivery, Electroporation, Iontophoresis, Electroosmotic flow

In vivo electroporation (EP) is a physical method for drug and gene delivery. EP is suitable for gene therapy applications in which a localized and transient expression of proteins is desired. In order to explore the electrokinetic contributions of DNA transport to gene delivery, an in silico tissue construct was created. This geometric representation of tissue was created using periodic level surfaces which approximate minimal. Minimal surfaces are found in nature from crystalline structures to biological nano and micro structures such as biomembranes, and osseous formations in sea urchin. The creation of such in silico tissue constructs can be extended into a platform for other biophysical studies.

Impact of an automated infusion system implementation on the process flow of medical radiology procedures

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Keywords: Process Flow, Technological change, Time study, Medical radiology

The goal of this study is to determine and document cost and labor savings as well as other potential process improvements resulting from integrating an automated infusion system into the preparation and dispensing of radiopharmaceuticals at Moffitt Cancer Center's PET, and the Tampa general hospital's nuclear medicine department. The center was observed where it did not include the use of the infusion system, and when it included the use of infusion system.

Integration of the automated Infusion System into the imaging procedures at the Moffitt Cancer Center in Tampa, FL has resulted in significant process improvements by reducing the infusion time by approximately, reducing distance traveled, and reducing worker strain by eliminating handling of individual shielded boxes. Another important impact of the Infusion System is related to the improved accuracy of the amount injected into the patients. Our observations indicate that the infusion System stands to be extremely effective especially in a busy department such as the one in Moffitt Cancer Center - due to its accuracy, pace and reliability, particularly after the necessary adjustments are made to reduce or eliminate the source of errors. This integration must be accompanied by a process reengineering exercise to realize the full potential of the Infusion System in reducing costs and improving patient care.

Graphene-Based Ultra-Sensitive Gas Sensors

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Keywords: Few-layered graphene, Gas sensor

In the present work, we report graphene-based gas sensors fabricated in high quality graphene synthesized via thermal chemical vapor deposition method. We were successful growing a monolayer of high quality graphene in a quartz tube furnace. In addition, Hall Effect experiment was conducted to estimate the electrical properties of the graphene layers. Graphene layers were tested to study the adsorption of NO_2, NH_3, and ethanol vapors at room temperature. The characteristics of the graphene-based sensor were observed to be dependent predominantly on the number of graphene layers used. In this work, we propose a mechanism to explain the dependence of gas sensing on graphene layers. Gas sensing via electronic sensitization and chemical sensitization through gas adsorption is found to be the dominant mechanism for sensor with1-2 graphene layer and 4-5 or more graphene layers, respectively. This mechanism was consistent for both the acceptor and donor type of gases. The responses of the grapheme-based gas sensor, microfabricated via standard lithography process, are highly reproducible.

Reconfigurable Antenna using Metamaterials and MEMS

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Keywords: Metamaterials (MTM), Micro-ElectroMechanical Systems (MEMS), Antennas.

Today the new trends in communications systems and specifically in remote sensing applications require electronic circuits at the microwave range. These circuits are expected to be able to adjust their operation for multiple bands, multiple modes and multiple standards. Moreover, when it comes to transmitters, they should be able to change the shape of their radiation patterns depending on the receiver in order to achieve maximum power transfer.

In recent years, emerging technologies, such as Metamaterials, have emerged that offer new paradigms in physics and engineering. The main focus of this research effort centers on integration of two technologies: Metamaterials (MTM) and Micro Electro Mechanical Systems (MEMS) for the development of a MTM-MEMS antenna, a three-dimension device that can provide very small and reliable "smart circuits" at a minimal cost.

The antenna is based on coplanar waveguide (CPW) technology; therefore, the signal and ground are in the same plane. The antenna presents lower dielectric losses and high signal integrity. The versatility of the developed antenna in this research has been successfully integrated an MEMS capacitor within a RF-MEMS. The capacitor is composed of two parallel plates capable of achieve a capacitance value from 0.69 to 1.57 pF in a gap of up to 4 microns between plates of the capacitor, with an actuation voltage between 0 to 40 V. Operating tunable frequencies between 5.3 to 5.8 GHz can be achieved by controlling the MEMS capacitors.

Variation in Microneedle Geometry to Increase Shear Strength

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Keywords: Microneedles; DRIE; Microfluidics; Lab-on-a-Chip; Bio-MEMS

This research aims to validate the effect of geometrical variations on the fracture strength of hollow silicon microneedles. Needle failure due to axial and shear loads may be due to heterogeneous peak stresses within the bulk material. Analytical determination of physical usage limits of microneedles can be misleading, as beam fracture models do not translate well to the micro-scale. Needle failure due to breakage can generally attributed to shear forces. In the study, 35 and 36 gauge hollow microneedles with a conventional circular lumen and those with enhanced 'letter I' shaped lumen geometry were fabricated. Due to their geometry, the 'I' shaped needles have a higher second moment of inertia, which leads to higher strength. The fracture limits of these needles due to shear forces were quantified. Average shear fracture limits of 36 gauge needles was 36.51 gf for circular geometry, while for the 'I' shaped needles it was 96.64 gf along the lateral direction. For 35 gauge needles the average fracture limits were 79.9 gf for circular needles, and 148.65 gf along the lateral direction for the enhanced geometry needles. Along the weaker axis, the enhanced geometry resulted in marginally lower strength than the circular counterparts for the 35 gauge needles, while it appreciably increased for the 36 gauge needles. The effect of geometry on shear strength was significantly higher for smaller microneedles.

Novel Islet-Sertoli Cell Hybrid Construct that is Immunoprotected and Secretes Insulin

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Keywords: Allografts, Aggregate, Cotransplant, Coculture, Electrofusion, Immunoprotection, Immunosuppressive, Islet Cells, Microgravity, Sertoli Cells

Cell Transplantation therapy is a potentially powerful tool for the treatment of diseases for which there are currently no practical cures. The replacement of defective cells with healthy cells offers the possibility of alleviating the destructive symptoms for many diseases such as Parkinson's disease, stroke, Alzheimer's disease, spinal cord injury, cirrhosis of the liver, factor-8 hemophilia and Type I diabetes. Insulin dependent, or Type I diabetes, remains one of the foremost health issues worldwide, and although many advances have been made to treat the symptoms of this devastating disease, little has been accomplished in actually curing this disease.

This study proposes to use third generation University of South Florida developed and patented electrofusion technology to create hybrid constructs composed of Islet and Sertoli cells. The primary advantage of producing this construct is that it would combine βeta cells from the Islets of Langerhans with Sertoli cells. Sertoli cells are derived from the testis and provide localized immunoprotection. This would alleviate the need for immunosuppressive medications often used for surgery. The fusion chamber utilizes gravity with an absorbent pad to remove the liquid from a suspension of cells leaving contacted cells on the membrane surface. The device was professionally manufactured by injection molding and bending of the outer aluminum electrodes to touch the membrane. The individual components of the prototype are assembled in the lab. Fusion yields of 25-30 percent were initially obtained. After further investigation with extensive optimization and the use of centrifugation to increase cell contact, the initial yields were validated using fluorescent microscopy. Flow Cytometry is now being incorporated into the research to accurately validate and characterize fusion yields and post fusion viability.

The research will then focus on novel hybrid constructs and will be produced under optimal conditions and tested for their capacity to secrete insulin in response to a glucose challenge and protect against the host immune system. Successful completion of this study will result in a novel secretory hybrid that will facilitate future animal model studies and advanced electrofusion methods.

In summary, cell fusion technology can be used to create novel hybrid cells. However, from a practical perspective, fusion yields with traditional methods have been too low. In addition, concerns about the safety of existing methods have restricted their use. USF researchers have devised a method and a practical device that results in high fusion yields and introduces no agents to the fusion partners that can cause safety concerns. The next logical step in the development of this fusion technology should be to create functional cell/tissue hybrids for cell transplantation therapy because it can be a powerful tool and potentially significant in the development of treatment protocols for serious diseases such as Type 1 Diabetes.

The Assembly of Micro Devices Using Capillary Forces

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Keywords: Self Assembly, Surface Tension, Thermoelectric Devices, Photovoltaic Devices

The evolution of technology is leading to smaller and smaller devices. One driving force for the shrinking size is the improved performance predicted/shown at micro and nano scale size ranges. Unfortunately current assembly methods require much time and expensive equipment and many times are incapable of assembling small scale systems. Self assembly is a process in which objects are positioned and oriented by random interactions. Capillary self assembly accomplishes this by making regions which have favorable surface energies for parts to lock onto and stay in place. The process by which this is done and the challenges presented by it are considered for two micro systems: thermoelectric coolers and photovoltaic power. Both applications show scaling benefits from microscale systems. In this poster we will show how we are using capillary self assembly to develop new methods of fabricating these micro devices. This includes the fundamentals behind capillary self assembly, the method of applying it to our devices and the experimental results of doing so.

Using Kinematics and Kinetics to Identify Distinctive Features of Wheelchair Transfers for Future Studies on Upper Body Biomechanics

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Keywords: Kinematics and kinetics, Lift phase, Wheelchair transfer

This is a preliminary study to observe and discuss what important results might be obtained from the comparison of the kinematics and kinetics of the transfer from wheelchair to bench and vice versa. Kinematic data was processed, analyzed and graphed to be able to observe important correlations that can further the understanding of the lift phase during wheelchair transfer and prevent common health issues provoked by the transfer process. Some of the important observations include: C7 is the best marker trajectory for kinematic data, kinetic data is observed prior to kinematic data and the leading hand exerts more vertical reaction force than the trailing hand in both directions of the transfer. Lastly, analysis of the transfer from wheelchair to a surface and vice versa is best when both kinematic and kinetics are used in conjunction.

Nanodiamond/Polyethylenedioxythiophene Nanowire Structures for Biosensing Application

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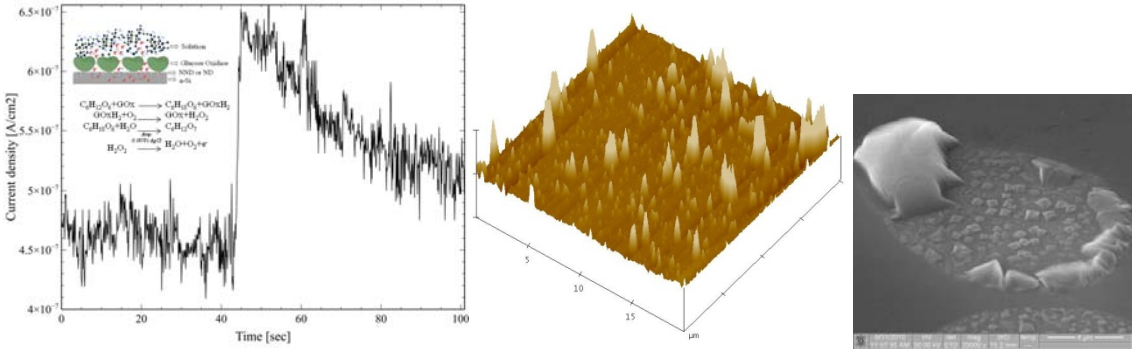
Keywords: Nanocrystalline diamond, Polyethylenedioxythiophene, Biosensing, Glucose oxidase, Chemical Warfare, Enzymes immobilized

This poster presents the biosensor implementation of Nanocrystalline diamond (ND) and polyethylenedioxythiophene (PEDOT) with co-enzymes for sensitive and specific quantification of glucose as well as chemical warfare stimulant (dimethyl methylphosphonate) substrates, respectively.

Nanocrystalline diamond (ND) in doped state has demonstrated exceptional and desirable properties such as conductivity, biocompatibility, and electrochemical stability which makes it highly suitable for the development of biosensors. On the other hand, the conducting polymer has been found to be an excellent matrix for the biosensor application. Under this work, we have integrated ND and highly conducting polymer by growing for the first time the 'polyethylenedioxythiophene' (PEDOT) nanowires on doped ND film by in-situ self-assembly technique. Later, the glucose oxidase (GOX) and choline oxidase (COX) have been functionalized separately with ND/PEDOT nanowire matrix for the development of glucose as well as chemical warfare biosensor. Biosensor response, in both cases, is gathered by electrochemical analysis (cyclic voltammogram and chronoamperometry) in terms of its stability under different electrolytes, and dynamic response against a step change. ND/polymer composite matrix is characterized using AFM, SEM, FTIR and Raman techniques for a complete physical and chemical description as well as understanding of the enzyme/matrix interaction. Biocompatibility was performed using MTT assay on HEK293 cells and growth curve for Gram negative bacteria *E. coli*. Further, adhesion capability was evaluated for the HEK cells under different concentrations of the matrix components using as a positive control polyethylene glycol.



(a)Chronoamperometric response (b) AFM Nanowires (c) SEM of HEK cell after experiment

Metal- polymer Interfaces

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Keywords: P3HT, PCBM, XPS, IDIS, UPS, Metal- organic interfaces

The energy level alignment between two prototypical conductive polymers, poly(3-hexylthiophene) (P3HT) and poly[2-methoxy-5-(2'-ethyl-hexyloxy)- 1,4-phenylene vinylene] (MEH-PPV) and metals was investigated with ultraviolet and x-ray photoemission spectroscopy (XPS, UPS) dependent on the metal substrate work function. In these experiments thin films of the polymer material were grown in several steps on in-vacuum cleaned metal substrates. In between deposition steps the surface was characterized with UPS and XPS without breaking the vacuum. This was enabled by electrospray polymer thin film deposition directly from solution, which allows the growth of clean macro-molecular films in vacuum. This enabled the measurement of the hole injection barriers and interface dipoles unaffected by environmental contamination artifacts. The presented results demonstrate a systematic dependence of the interface dipole on the substrate work function. This indicates that the charge neutrality level-based “induced density of interface states” (IDIS) model also holds for nonreactive conductive polymer/metal interfaces.

Capacitively-transduced MEMS Resonator Fabricated by IC-Compatible Low Temperature Process

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Keywords: MEMS, Resonator, High-Q, Electroplating, ALD, Dielectric

Vibrating micromechanical disk resonators which apply the Nickel metal material as the structure and use a solid dielectric capacitive gap deposited by Atomic Layer Deposition technology can present good performance to get high-Q in high frequency. Despite the drift problems encountered in early attempts to use nickel as a structural material in MEMS devices, this low temperature fabrication technology has advantage for post-transistor planar integration. The nickel structure is deposited through the electroplating process which is an important deposition method because it enables the metal to have extremely high aspect ratio structures and the setup of electroplating in the research laboratory is much cheaper compared to the other deposition facilities. Also the electroplating process can be done under the temperature of 40ºC which is low enough to post-process over the finished Integrated Circuits. In order to lower the motional resistance, a solid dielectric gap is applied instead of an air gap and provides other benefits compared to the air gap such as better stability, eliminating the particles. By using atomic layer deposition (ALD), an ultra thin dielectric gap can be deposited under 100 ºC while obtaining a film with great uniformity and conformality.

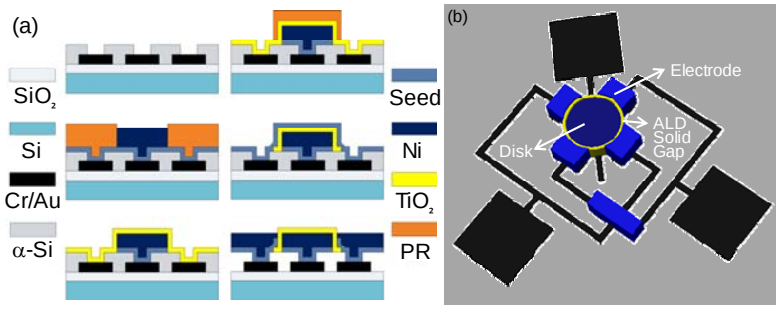

Figure1. (a) Cross-sectional and 3D schematic view of the fabrication process flow for capacitively-transduced disk resonator constructed using electroplated Ni.

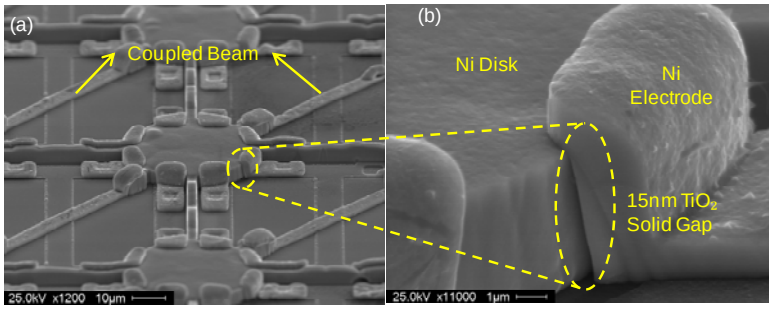

Figure2. SEM photos of (a) microfabricated disk resonator array in electroplated Ni, and (b) 15nm-thick ALD TiO_2 electrode-to-resonator solid gap.

Electronic Structure of Self-Assembled Peptide Nucleic Acid Thin Films

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Keywords: PNA, Self assembled monolayer, SAM, Thymine, Cysteine, XPS, UPS, Charge transfer

This poster explores the electronic structure of interfaces between self-assembled monolayers (SAMs) of peptide nucleic acid (PNA) and the Au substrate on which the monolayer forms.

PNA is a synthetic analog of DNA with a neutral backbone usually based on N-aminoethyl glycine and PNA SAMs are of interest for applications in molecular recognition, bio-sensing, and molecular electronics.

Cys-containing PNA 7-mers of thymine (Cys-T7) were incubated on Au substrates in a nitrogen glove box attached to a photoemission spectrometer. Ultraviolet and x-ray photoemission spectroscopy (UPS and XPS) measurements on the resulting SAMs revealed the hole injection barrier at the interface and the interface dipole. Electronic structure calculations based on molecular dynamics sampling of the PNA structure yielded the HOMO-LUMO gap and the molecular orbitals density of states. In combination with the UPS data, this enabled the estimate of the electron injection barrier at the interface, as well as the assignment of individual UPS spectral features to specific molecular orbitals.

Additional measurements on Cys-containing, abasic PNA allowed the identification of the emissions related to the PNA backbone in the UP spectra. The orbital line-up at the interface between the Au and the Cys-containing PNA showed a significant interface dipole resulting in the alignment of the Au Fermi level near the center of the HOMO-LUMO gap of the Cys-containing PNA. This causes large charge injection barriers for both holes and electrons, and thus impedes charge transfer from Au into the SAM.

The computed orbital line-up provides both a framework for interpreting future experiments on PNA monolayer conductivity and a roadmap for the design of organic molecule-based nanodevices and biosensors.

Nanomechanical Properties of TiO_2 Granular Selfcleaning Thin Films

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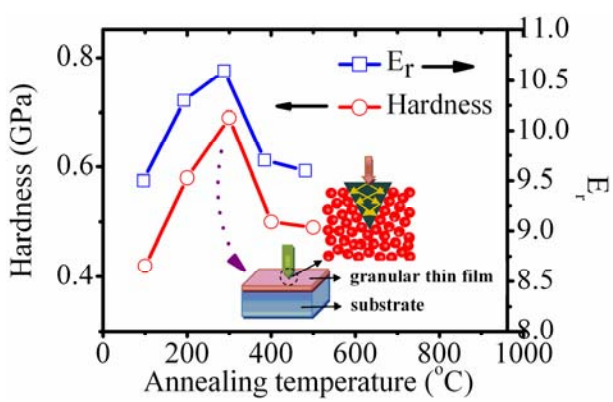
Keywords: Selfcleaning, Photocatalyst, Nanoindentation, Berkovich indenter

Post-deposition annealing effects on nanomechanical properties of granular TiO_2 films on glass substrates were studied. In particular, the effects of Na diffusion on the films' mechanical properties were examined. TiO_2 photocatalyst films, 330 nm thick, were prepared by dip-coating using a TiO_2 sol, and were annealed between 100°C and 500°C. Film's morphology, physical and nanomechanical properties were characterized by atomic force microscopy, X-ray photoelectron spectroscopy, X-ray diffraction, differential thermo-gravimetric analysis and nanoindentation. Contrary to expectations, the maximum film hardness was achieved for 300°C annealing, with a value of 0.69±0.05 GPa. Higher annealing temperatures resulted in inferior mechanical properties. No pile-up or sink-in effects were observed with minimal creep for the 300°C annealed sample. Considerable decrease in the amount of chemisorbed water was found with increasing annealing temperature, causing gel films densification, explaining the increasing trend of hardness with annealing temperature between 100°C and 300°C. DTA/TGA results also confirmed the weight loss and the endothermic reaction due to desorption of chemisorbed water. Decrease in hardness above 300°C annealing is attributed to thermal diffusion of Na ions from the glass substrate, confirmed by nanoindentation tests on TiO_2 films deposited on fused quartz, which did not exhibit hardness decrease after 300°C annealing.



Research Category #3: ***Sensing, Networking, Communications, Computing, Biometrics and Pattern Recognition***

Fractional Reuse Partitioning Schemes for Clustered Cellular Communication Systems

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Keywords: Adaptive cluster size, Capacity, Cellular systems, Channel allocation, Fractional frequency reuse, Grade of service, Overlay architecture, Reuse partitioning

In this poster, we propose that an overlaid cellular clustering scheme which uses adaptive fractional frequency reuse factors would provide a better capacity by exploiting the high level of signal to interference ratio (SIR). The presented methods are studied via simulations and the results show that the adaptive clustering with optimization provide a better capacity and grade of service (GoS) comparing to the conventional cellular architectures.

Conventional cellular systems have not taken full advantage of fractional frequency reuse and adaptive allocation due to the fixed cluster size and uniformed channel assignment procedure. This problem can even cause more fatal consequences considering the 4G standards which have higher data rate requirements such as 3GPP-LTE and IEEE 802.16m (WiMAX). In this poster, we present two partitioning schemes for adaptive clustering with fractional frequency reuse namely maximal fractional reuse partitioning (MFRP) and optimal fractional reuse partitioning (OFRP).

Effect of Link-Level Feedback and Retransmissions on the Performance of Cooperative Networking

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Keywords: Cooperative Communications, Cooperative Networks, Network Coding, Clustering, Link-level feedback, Retransmission, Throughput

In this poster we present *Cooperative Networking* (CN) is a novel technology that synergistically integrates Network Coding with Cooperative Communications to produce superior reliability and provide inherent security features, while improving the network throughput for a large class of networks.

Specifically, we consider the effect of link-level feedback and retransmissions on the performance of wireless sensor networks using Cooperative Networking, and we present scenarios where link-level retransmission offers a significant improvement in network throughput. We found that link-level retransmission provides higher throughput for systems using Cooperative Networking when the number of nodes per cluster is relatively small and/or the connectivity of the network is low and/or the probability of transmission loss of a link is high. That is, Cooperative Networking with link-level retransmission provides higher throughput when the network node density is low (i.e., for sparse networks).

Developing an Optimal Classifier Model for Lung Tumors from CT-scan Images

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Keywords: CT-scan, Image features, Classifier, Decision tree, Support vector machines, Feature selection, Relief F, Wrapper, Leave-one-volume out

A CT-scan is a vital tool for diagnosis of Lung cancer. Although the tumor can be detected easily using imaging techniques like CT, definitively determining the type of tumor requires invasive techniques such as a biopsy. Hence a fast, relatively accurate, automated tumor class predicting tool can serve a role in expediting the diagnosis and treatment of Lung cancer.

We describe our work to develop a classifier for classifying lung tumor type based on the 2-D image features extracted from CT-scan images of the lungs. Once the tumor has been segmented from the CT-images, we calculate 102 image features, which include geometric features, boundary features and texture features from the segmented tumor object from each slice of the CT image for each tumor volume. Based on those feature values we build a classifier model. The classifier models put a tumor into one of the two classes, Adenocarcinoma and Squamous-cell Carcinoma. We evaluated the performance of classifiers including decision tree and support vector machines. We also searched for performance improvement by reducing the feature space using feature selection methods, e.g. Relief F and Wrapper. We provide a comparative analysis of the performance of J-48 decision tree and Support Vector Machine with Radial Basis Function Kernel along with the effect of different feature selection techniques. For 17 cases, we evaluate the different models by calculating the average accuracy of each model over a Leave-one-Volume out experiment. We find that there is general improvement in performance when performing feature selection. Decision trees implicitly perform feature selection and hence show much better accuracy compared to SVM when no feature selection technique is employed. However, applying feature selection immediately brings about substantial improvement in the performance of SVMs. The accuracy results on performing Leave-one-volume-out on 17 tumor volumes, using a total 102 image features, are as follows. When no feature selection techniques are used, J-48 results in an average accuracy of 52.94 % while SVM has an accuracy of 35.29%. When Relief-F feature selection is employed to build a model on 50 features there was an increase in accuracy for J-48 to 64.71% but the accuracy remains the same for SVM. SVM also remains unchanged when Relief F feature selection is used to select 25 features. But J-48 accuracy goes down to 47.06%. Finally, when Wrapper feature selection is used, with respective classifiers as the underlying classifier, and the forward selection method is used, the accuracy with SVM makes improves to 70.58%, but does worsens the J-48 accuracy by leaving it with too few features (7) to choose from.

BLOGS: Balanced Local and Global Search for Non-Degenerate Two View Epipolar Geometry

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Keywords: Joint Feature Distributions, Epipolar Geometry

This work considers the problem of estimating the epipolar geometry between two cameras without needing a prespecified set of correspondences. It is capable of resolving the epipolar geometry for cases when the views differ significantly in terms of baseline and rotation, resulting in a large number features in one image that has no correspondence in the other image. We do conditional characterization of the probability space of correspondences based on Joint Feature Distributions(JFDs). We seek to maximize the probabilistic support of the putative correspondence set over a number of MCMC iterations, guided by proposal distributions based on similarity or JFD. Similarity based guidance provides large movements (global) through correspondence space and JFD based guidance provides small movements (local) around the best known epipolar geometry the algorithm has found so far. We also propose a simple and novel method to rule out, correspondences that lead to degenerate configurations, thus speeding up convergence. We compare our algorithm with LORANSAC, NAPSAC, MAPSAC and BEEM, which are the current state of the art competing methods, on a dataset that has significantly more change in baseline, rotation, and scale than those used in the current literature. We quantitatively benchmark the performance using manually specified ground truth corresponding point pairs. We find that our approach can achieve results of similar quality as the current state of art in 10 times lesser number of iterations. We are also able to tolerate upto 90% outlier correspondences.

Hydrodynamic Computation of Water Circulation in a Pool

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Keywords: Pool Skimmer

Pool skimmers play an important role within a pool's drainage system. These devices, installed on the pool walls near the surface, have the purpose of capturing as much water from the surface as possible; the captured water then gets flushed into the draining pipe system and directed for cleaning and filtering before returning back into the pool. The efficiency of the skimmer can be measured by the magnitude of its water entrainment radius. The larger the entrainment radius of the skimmer is, the higher its capability of capturing water from a distance far away from its location.

The work for this project involves developing a three-dimensional computational hydrodynamics model of the water circulation in a pool, and analyzing output from the model in order to quantify the surface water flushing (filtering) efficiency of a particular skimmer design. Once quantitative data of the water flow and the skimmer efficiency has been gathered, an improved skimmer design will be tested and results will be compared with ordinary, commercial devices. Ultimately, the new skimmer design will serve to lower energy demands required to satisfy surface water flushing standards.

Narrowband Interference Mitigation for SC-FDE Systems based on Zeroing and Iterative Methods

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Keywords: Coexistence, Interference cancellation, Iterative, NBI, SC-FDE, SC-FDMA, Uplink, Zeroing

Interference cancellation will become more important in next generation wireless communication systems due to the lack of available spectrum. In this poster, a narrowband interference (NBI) cancellation receiver is proposed which can be used for single-carrier frequency domain equalization (SC-FDE) and single-carrier frequency-division multiple access (SC-FDMA) based systems. In the proposed receiver, impact of NBI is mitigated by modified zeroing and iterative interference cancellation (IIC) methods. If the NBI is detected on the desired band, overlapping NBI spectrum is zeroed at first iteration, followed by demodulation and regeneration of the desired signal. Afterwards, the zeroed overlapping samples are replaced by the corresponding samples of the regenerated signal. In order to improve the performance, demodulation and regeneration stages can be repeated multiple times. On the other hand, if the signal-to-interference plus noise ratio (SINR) of the desired signal is larger than a threshold, no IIC is applied. Simulation results show that with respect to a conventional receiver, important gains can be achieved at low to medium SINR levels.

The Role of Social Networking Sites in Promoting Inter- and Intra- Organizational Collaboration and the Impact on Operational Performance

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Keywords: Cyber-enabled social networks, Collaboration, Knowledge transfer

Intellectual Merit: Organizations collaborate within social networks to improve operational performance. Although there is a growing use of online social networks for business purposes, we know very little regarding how effective these cyber-enabled social networks are at fostering collaboration and improving performance outcomes. In particular, it is not known if such online networks can aid the development of network ties that are strong enough to support the transfer of proprietary information and complex knowledge.

Broader Impact: This research has the potential to influence public policy regarding the use of cyber-enabled social networks to promote growth and innovation in areas of national need. One research site will be the medical device industry in the Tampa Bay region. Thus, the research will inform policy at both the national and regional levels.

Transferability: The results will be transferable across similar industries. Moreover, the research will enhance the infrastructure for research and education across Central Florida in support of both students and the mainly small businesses that comprise the medical device industry in the region.

Cavity-Backed Folded-Slot Antennas

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Keywords: Cavity-backed folded-slot antenna (CBFSA), Folded-slot antenna (FSA), Coplanar waveguide (CPW), Unidirectional radiation, Shallow cavity

This poster presents two designs of a cavity-backed folded-slot antenna (CBFSA), which consist of a shallow rectangular dielectric-filled cavity placed on a folded-slot antenna (FSA), which is fed through coplanar waveguide (CPW). The cavity and FSA were aligned through their centers. The designs proposed are simulated in the High Frequency Structure Simulator (HFSS). Simulations and measurements showed that the CBFSAs are able to focus the radiation, even when shallow ($\leq \lambda/4$) cavities are used. The proposed antennas operate at 4.3 and 5GHz and have front to back ratios (FBR) in the range of 15 dB-20 dB. The unidirectional radiation capability of the CBFSA could be of interest toward achieving size reduction and miniaturization of communication devices.

Long Range Sensor Interrogation: Remote Lock-In Amplification

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Keywords: Wireless sensors, Harmonic re-radiator, Rectenna, Lock-In Amplifier

The Remote Lock-In Amplifier (RLIA) is a novel system approach involving a remote ultra low power sensor/transponder device that measures and quantifies some general-purpose signal in a field environment (vibration, temperature, light, etc.). The remote device is interrogated by a signal from a base-station or mobile platform, where a signal from the base-station is transmitted at a certain chopping frequency and is received by the remote sensor and modulated based on the measured phenomena within the sensor's environment. The remote sensor/transponder receives a signal at 1.3 GHz, modulates and retransmits at 2.6 GHz.

At the base-station a lock-in-amplifier, which utilizes phase sensitive detection, recovers the retransmitted signal from the sensor/transponder by singling out the component of the signal at the chopping frequency. The process is unique as the Lock-In amplification is done in a remote manner. Received signals can be demodulated at very low received power levels (within nano-volt ranges) well within the noise floor.

Relational Entropy-based Measure of Saliency

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Keywords: Rényi's Entropy, Relational Distributions, Scale Variation, Saliency, Bottom-up

Human eye fixation points occurring during the early stages of visual processing often correspond to the loci of salient image regions. These salient regions provide us with assistance in determining the interesting parts of an image and they also lend support to our ability to discriminate between different objects in a scene. They attract our immediate attention without requiring an exhaustive scan of a scene and they possess some quality that enables them to stand out in relation to their neighbors.

In this poster, we present a bottom-up measure of saliency based on the relationships exhibited among image features. We adopt the standpoint whereby the relationships among the features determine more of the perceived structure in an image rather than the individual feature attributes and we seek those structures which "pop-out." We capture the organization within an image by employing relational distributions derived from distance and gradient direction relationships exhibited between image pixels. We evaluate the performance of our measure in relation to a dominant saliency model and obtain comparable results. In an effort to derive meaningful information from an image, we also investigate the significance of scale relative to our saliency measure.

Automation of Unbiased Stereology Methods for Analysis of Biological Microstructures

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Keywords: Autofocus, Microscopy, Absolute Threshold Gradient, Color Thresholding

Quantitative analysis of biological microstructures using unbiased stereology plays a large and growing role in bioscience research. The aim of this project is to add a fully automatic, high-throughput mode to a commercially available, computerized stereology device (Stereologer). The current method for identification of optical planes and estimation of first and second order stereology parameters of biological microstructures requires a trained user to manually select the top and bottom of the tissue and the objects of interest (cells, fibers, etc.). To automate finding the correct focal planes, i.e. the in-focus optical planes at the top and bottom surfaces of the tissue sections, several gray scale focusing algorithms were analyzed. Traditional microscopy focus algorithms attempt to find global maximums on the focus curve while in this project the aim is to find the sharp "knees" on the autofocus curve that represent two "just out-of-focus" optical planes when moving from unfocused to focused regions on the upper surface of the tissue section; and, when moving from the focused to unfocused regions on the lower surface.

The approach used for identifying and counting the objects of interest is a combination of color and gray-level processing. Color processing is used to identify the objects of interest. A training set is used to obtain a threshold targeting specific objects that have been stained during slide preparation. The RGB color space is converted to HSI for this step and the threshold is set using both hue and saturation values. This is followed by gray-level processing; the processed images are segmented again to further isolate the objects of interest. Finally a region growing approach is used to identify and count the number of objects.

Thirty stacks of images on three sections of rat brain tissue were obtained consisting of 600 by 800 pixel images at 1 micron intervals through the tissue depth. Nine different focus algorithms to locate in-focus optical planes were compared. The algorithm based on filtered threshold absolute gradient outperformed the others. This automated approach correctly found the top or bottom plane section of a specimen within 1 micron on average on our training data and within 1.5 microns on our test data. The automated approach for object detection achieved an overall rate of 93%. Thus, these results support the view that automatic image analysis, combined with unbiased sampling and parameter estimation, can support accurate and efficient automatic quantification of biological objects in stained tissue sections.

Tracking Ships from Fast Moving Camera through Image Registration

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Keywords: Visual maritime traffic surveillance, Buoy-based surveillance, Detection, Tracking, Ship, Marine vehicle, Localization, Horizon detection, Image registration, Image segmentation

This work presents an algorithm that detects and tracks marine vessels in video taken by a non-stationary camera installed on an untethered buoy. The video is characterized by large inter-frame motion of the camera, cluttered background, and presence of compression artifacts. Our approach performs segmentation of ships in individual frames processed with a color-gradient filter. The threshold selection is based on the histogram of the search region. Tracking of ships in a sequence is enabled by registering the horizon images in one coordinate system and by using a multi-hypothesis framework. Registration step uses an area-based technique to correlate a processed strip of the image over the found horizon line. The results of evaluation of detection, localization, and tracking of the ships show significant increase in performance in comparison to the previously used technique.

Design of a Comparator Tree Based on Reversible Logic

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Keywords: Comparator Tree, Reversible Logic, Binary Comparator

The existing design of reversible n-bit binary comparator that compares two n-bit numbers is a serial design [1] having the latency of O(n). In this work, we present a new reversible n-bit binary comparator based on binary tree structure that has the latency of $O(\log_2 (n))$. The reversible designs are based on a new reversible gate called the TR gate, the improved quantum cost of which is also derived in this work. In the proposed reversible binary tree comparator each node consists of a 2-bit reversible binary comparator that can compare two 2-bit numbers $x(x_i, x_i\text{-}1)$ and $y(y_i, y_i\text{-}1)$, to generate two 1-bit outputs Y and Z. Y will be 1 if $x(x_i, x_i\text{-}1) > y(y_i, y_i\text{-}1)$, and Z will be 1 if $x(x_i, x_i\text{-}1)<y(y_i, y_i\text{-}1)$. After careful analysis, we modified the logic equations of $Y = x_1 \bar{y}_1 + kx_0\bar{y}_0$ and $Z = \bar{x}_1y_1 + k\bar{x}_0y_0$ to $Y = x_1 \bar{y}_1 \oplus kx_0\bar{y}_0$ and $Z = \bar{x}_1y_1 \oplus k\bar{x}_0y_0$, respectively. The replacement of + operator with $\oplus$ operator without affecting the functionality of the design helped us in reversible mapping of the equations of Y and Z on the third output of the TR gate which is $R=A\bar{B}\oplus C$. Further, TR gate can also efficiently generate functions such as x_0y_0 and x_0y_0. In the proposed reversible binary comparator, the leaf nodes will consist of 2-bit reversible binary comparators. Each internal node (2-bit reversible binary comparator) of the binary tree receives the partial comparison results from the left and the right children and propagates the 2- bit output of the comparison to its parent. Finally, the root node which is also a 2-bit reversible binary comparator generates the 2-bit result of the comparison of the n-bit numbers x and y to evaluate whether x>y or x<y. The 2-bit result of the root node are passed to the reversible output circuit designed from a Toffoli gate and 4 NOT gates to generate three signals O_0 (x<y), O_1 (x>y) and O_2 (x=y).

Coaxial Probe for High Temperature Dielectric Characterization

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Keywords: Open-ended coaxial probe, Spring-loaded probe, High temperature measurement, Reflection coefficient, Permittivity

For proper design and construction of RF/microwave devices that are intended to operate over a wide temperature range, it is important to know how the electrical properties of the material used in their construction change with temperature. In order to determine this, a measurement system that would withstand elevated temperatures was developed.

The research being presented consists of the design and construction of a spring-loaded stainless steel open-ended coaxial probe used to find the electrical properties of materials at elevated temperatures. This research uses network analyzer measurements of the reflection coefficient on an open-ended coaxial sensor in contact with a material. Permittivity is then extracted from the reflection coefficient data by the use of a lumped equivalent circuit model of the sensor's fields fringing into a sample. Computer verification of the technique is demonstrated, and results for two materials at a frequency range between 0.5 GHz - 1.8 GHz are measured at room temperature, 45 °C, 75 °C, and 100 °C.

Spatial Distance Histogram Computation Using Locality Information

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Keywords: Query processing, Locality, Spatial distance histogram (SDH)

Molecular simulations generate large amount of data that needs to be stored and managed efficiently. The query processing of this data imposes even greater challenges in terms of time consumption, due to the high volume of data. Most of the queries applied to this type of data are analytical, and if the straight forward method of query processing is being used, they take super-linear time to get processed.

One of the basics analytical quires, most commonly used in the analysis of the MS data sets is the Spatial Distance Histogram (SDH). The running time of the SDH query processing is of quadratic order (of the number of data particles). Often, in order to analyze the simulation of the system over a period of time, the SDH query is being executed multiple times. This increases the overall executing time to get the SDH.

In this poster, we present a novel idea, an approximate algorithm for computing the SDH efficiently and with very limited error margin. We use a quad-tree data structure to efficiently store the data and to process multiple SDH queries in logarithmic time. We use the locality information of the atoms in each node of the tree to determine their distribution. We observe this distribution over multiple time frames of the SDH. We use the SDH of frame i to compute the SDH of frame j ($i<j$). This way we decrease the computational time of the overall SDH processing.

The efficiency of the proposed algorithm is supported by mathematical analysis of the running time. We present several experimental results to confirm the analysis and show the accuracy of the algorithm.

Small Dual Band Coupled Double Loop Antenna for Miniature GPS/GNSS Anti-Jam Array

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Keywords: GNSS, GPS, Miniature Antenna, Dual Band, Anti Jam Array, Metamaterials, Electromagnetic Band Gap (EBG)

Signals from Global Navigation Satellite System (GNSS) and Global Positioning Systems (GPS) are, in general, weak and prone to jamming in military operations. Currently available anti jam GPS arrays, composed of multiple (typically 5-6) antenna elements, overcome this issue through beam steering; however they occupy excessive space and weight. Miniature antennas can play a significant role to enable this technology for new generation of small unmanned aerial and land military vehicles. In this work we present small GPS antennas for miniature anti-jam arrays operating at both L2 (1227 MHz) and L1 (15575 MHz). Our approach is to employ mode diversity and higher order dispersion (K-ω) curves of periodically arranged and reactively loaded printed coupled lines. Multi band operation is achieved by exciting each of the coupled lines simultaneously. We demonstrate that this approach leads to 50% size reduction as compared to traditional patch and stack patch antennas. Another issue with miniaturization of anti-jam GPS array is the undesired interference among the antenna elements due to electromagnetic coupling. To isolate the antennas from these coupling effects, we proposed miniature GPS antennas with electrically small electromagnetic band gap (i.e. EBG) structure. Antenna performance and isolation coupling studies will be shown at the time of presentation.

Investigation of Antenna-Based Multi-Path Mitigation Methods using a Bench-top Wireless Channel Emulator

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Keywords: Electromagnetic absorber, Directional antennas, Omni-directional antennas, Antenna diversity

A bench-top, hardware-based system capable of emulating varying multi-path conditions common in wireless communications links is under development. This system, called the Compact Reconfigurable Channel Emulator (CRCE), is capable of producing over a million discrete channel conditions via electronic and mechanical re-configurations. In this work the ability to control the severity of multi-path effects in a given channel condition, through the introduction of small volumes of electromagnetic absorbers, is being explored. In addition, the effects of using directional versus omni-directional antennas, and the use of diversity antenna configurations are being studied. All of this increased variability will provide the capacity to measure the effects and efficacy, through statistical analysis, of every modifier mentioned on proposed antenna concepts, in order to create antenna setups apt to specific communications links. Encompassed in this are software improvements aimed at interpreting these measurements through the use of cumulative distribution functions (CDF's) and at increasing the reliability and user-friendliness of the CRCE to a wider potential audience.

Developing SPICE models for Simulation and Stress Analysis

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Keywords: Simulation, Modeling, SPICE, Modelithics, Agilent

Simulated Program with Integrated Circuit Emphasis, or SPICE, is a well known tool for simulating electronic circuits in academia and industry alike. With SPICE, small signal behavior, DC conditions, transient and noise analyses can be achieved by attaching components into a circuit via a net list and setting parameters for the simulation. SPICE simulations allow manufacturers to design and test board level components before they are brought to market, or in the case of a student, provide another tool to understand component behavior. Through a USF grant sponsored by Modelithics in collaboration with Agilent Technologies, SPICE models and stress analysis harnesses are developed for ferrite chip beads to model behavior in varying conditions.

Typically, a ferrite chip bead acts to suppress noise levels at RF frequencies in AC circuits and common mode noise in DC conditions. An ideal inductor resists change in direction of current by storing energy within the magnetic field around its coils, thus accumulating a voltage and providing reactance with no losses or capacitance. Ferrite beads act as a very poor inductor, with a very low ratio of reactance to resistance, or Q factor. The low Q factor, however, gives them their noise suppression characteristics at RF frequencies. Additionally, the internal parasitic capacitances and resistive losses when using a ferrite bead require that an ideal inductor would not prove adequate to model a ferrite chip bead. Furthermore, as the current through the ferrite bead increases, the inductance of the component decreases as the magnetic core saturates, changing its impedance at relatively lower frequencies. Therefore, a passive parallel resistor, inductor and capacitor (RLC) network is modeled in the SPICE environment, according to device information supplied by the component's manufacturer. Parallel RLC networks typically function as a simple band pass filter, whose characteristics are described by well known equations. These equations are able to provide a sufficiently accurate approximation to the network's RLC values for component stress analysis purposes. After an adequate AC simulation is provided for, a transient analysis harness is developed in order to test component stress, such as maximum allowable current, as specified by the manufacturer's data sheet.

Detecting Group Turn Patterns in Conversations using Audio-Video Change Scale-Space

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Keywords: Scale-Space, Group Turn, Bayesian Information Criterion

Automatic analysis of conversations is important for extracting high-level descriptions of meetings. In this work, as an alternative to linguistic approaches, we develop a novel, purely bottom-up representation, constructed from both audio and video signals that help us characterize and build a rich description of the content at multiple temporal scales. We consider the evolution of the detected change, using Bayesian Information Criterion (BIC) at multiple temporal scales to build an audio-visual change scale space. Peaks detected in this representation, yields group-turn based conversational changes at different temporal scales. Conversation overlaps, changes and their inferred models offer an intermediate-level description of meeting videos that can be useful in summarization and indexing of meetings. Results on NIST meeting room dataset showed a true positive rate of 88%.

Data Compression for Molecular Simulations

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Keywords: Molecular simulations, Encoding, Data compression, Eigen transformation, Discrete cosine transformation

Storage of large molecular dynamics (MD) simulation measurements in standard databases is a challenging task. The requirements on disk space, input/output (I/O) and data transfer bandwidth are excessively high due to the large volume, possibly terabytes or petabytes, of data generated. Storage of data in compressed form has been a popular approach to address such issues. In this paper, we present a lossy compression framework that yields significant performance gain by combining the strength of the principal component analysis (PCA) and discrete cosine transform (DCT).

In our framework, the MD data are first transformed, using PCA, from the generic 3-D coordinate space to another 3-D eigen space, with the dimensions sorted in decreasing importance levels in capturing the variance of the atoms's movements. In the eigen space, the DCT is applied to each dimension to achieve lossy compression across a number of consecutive atom frames. The combination of the PCA and DCT ensures that our framework is able to (1) achieve balanced compression across 3-D coordinate space, (2) realize dynamic error control and avoid the propagation of the compression errors and data corruptions; and (3) ensure random access to any portion of the data without fully decompressing the whole data file. Experimental results using real simulation data show that the data storage space requirement is reduced by a large magnitude while achieving a compression ratio of about 13. Errors comparable to the existing techniques are achieved with minimal computational overhead.

Centinela: A Human Activity Recognition System Based on Acceleration and Vital Sign Data

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Keywords: Structural detectors, Machine learning, Mobile applications, Human-centric sensing

In the present work, Centinela is presented as a new system that combines acceleration data with vital signs to achieve highly accurate human activity recognition. Five activities are to be recognized: walking, running, sitting, ascending, and descending. The system includes a portable and unobtrusive real-time data collection platform which only requires one single sensing device and a mobile phone. To extract features, both statistical and structural detectors are applied, and two new features are proposed to discriminate among activities during periods of vital sign stabilization.

After evaluating eight different classifiers and three different time window sizes, Centinela achieved up to 95.7% overall accuracy, which is higher than for other approaches under similar conditions. It was also shown that vital signs are useful to discriminate between certain activities. Indeed, Centinela achieved 100% of accuracy for activities such as running and sitting, and it improved the classification accuracy for ascending in roughly 13% regarding to the accuracy achieved by only considering acceleration data.

Miniaturization of Microwave Filters

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Keywords: Cross coupled filters, Capacitive loading, Slow-wave resonators, ESR, Insertion loss, Quality factor

Filters are among the largest structures in a microwave device, and different miniaturization techniques have been employed to address this issue. However, these techniques usually have a negative impact on the performance of the filter and modern systems impose very demanding performance constraints on them. Clearly, small electrical size and ultimate performance are two competing goals.

Microwave filters having cross coupling between non-adjacent resonators can easily achieve the performance necessary for today's standards. We apply capacitive loading to modern resonators used to design cross coupled filters in order to miniaturize them. Within this project we expect to establish theoretical and practical limits on the tradeoff between the size of the resonator, the reactive loading, and the filter insertion loss. As a by-product, we have also unveiled a potential problem with the current measurement standard of quality factors of surface mounted capacitors.

Dual-Channel Ethernet for Improved Energy Efficiency

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Keywords: Energy Efficient Ethernet (EEE), Dual-channel Ethernet link

The IEEE 802.3az Energy Efficient Ethernet (EEE) uses low-power idle to achieve energy efficient operations for low offered loads. In EEE a wake-up overhead is needed before transmitting a frame (or block of contiguous frames) followed by a return-to-sleep overhead to return the link to low-power idle. This overhead will result in poor energy efficiency when the total overhead time is large compared to the total frame(s) transmission time. We propose the new concept of a dual-channel Ethernet link where one channel operates at low-power and low speed (e.g., 1 Gb/s) and is always on while the second channel operates at high speed (e.g., 10 Gb/s) and uses EEE. We show that a dual-channel 1 Gb/s and 10 Gb/s Ethernet can achieve both lower energy consumption and lower packet delay than a single 10 Gb/s Ethernet with EEE. The key contribution is to argue that multiple-channel links deserve further attention as a possible means of reducing direct energy consumption of wired communications links for packet switched networks.

Bioimpedance Change during Electroporation as an Indicator of DNA Delivery Effectiveness

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Keywords: Electroporation, Bioimpedance, DNA Delivery Methods.

Induced cell's membrane permeability is essential for the uptake of drugs, DNA, genes and proteins into the cytoplasm. Electroporation (EP) seeks to optimize permeability by decreasing the tissues' electrical bioimpedance (EBI) to its reversible lowest value. Excessive EP treatment results in unwarranted cell death and the opposite yields tapered permeability. Online (instant) EBI measurements feedback for *in vivo* EP tissues protocols are preferred in order to minimize delays since cell viability is a function of the time elapsed after EP. Current methods are slow, cumbersome, and use bulky and expensive equipment. Measuring electrodes collect undesired data of surrounding over-treated tissue. There is limited reported data on quantitative decreases on *in vivo* EBI immediately before and after EP. This work introduces a novel method to help overcome those shortcomings by providing instant pre/post EP-EBI measurements and feeding changes online (real-time) by using an inexpensive impedance analyzer microchip (IAM) in conjunction with a novel electrode configuration. Two electrode sets infuse electrical fields shifted by 120^0 -to increase tissue exposure, and another set measures -which minimizes errors arising from electrode polarization, while the IAM is clocking bioimpedance changes from 5 to 100 kHz, all within two seconds. *Ex vivo* bovine liver and *in vivo* mice and rats' skin are measured upon the application of 150V/cm or 200V/cm electric fields using four alternating unipolar square pulses of 20ms duration at one second intervals each via hexagonal surface electrodes, and keeping treatment volume constant at 3.2 cm^3. This works shows that lower electrical fields can yield higher impedance drops. Subsequent work measures EP-EBI on *in vivo* murine skin, liver, kidney, heart, and muscle.

Design and Development of a Participatory Sensing System Using Location Based Information Systems and Sensor Integration

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Keywords: Participatory sensing, Pollution monitoring, Location-based information systems, Data visualization, Sensors integration

The number of cellular phones has increased in the past 15 years reaching five billion devices during the current year. Each day, these devices are more and more capable of collecting, processing, and transmitting information obtained by multiple sensors such as Global Positioning System (GPS) receivers, accelerometers, and some others that can be attached to them. Thanks to these new features, mobile phones can be considered mobile sensing devices with the potential to provide information like never before to address large-scale societal problems. This project designs, develops and tests a general mobile information sensing system that measures temperature, relative humidity (RH), air quality, and other important variables (carbon monoxide, carbon dioxide and combustible gases), and shows the readings as overlays in a Google map. With the collaboration or participation of all cellular phone users, these variables can be measured and monitored in real-time for global warming and pollution monitoring and control, as well as many other health-related and location-based applications. This system is the base platform for Participatory Sensing applications that are being developed in the CommNet research group at USF.

USF Library Expenditure Optimization

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Keywords: Engineering, Industrial, Optimization, Library, Efficiency

One of the most important aspects of any University is its library system, which provides the whole campus population access to both classical and contemporary information. Currently, the University of South Florida spends a little over $6 millions on library materials every year. However, given the size of USF and diversity of departments and research areas, such funding is nearly not sufficient. This raises several critical questions: how can this money be allocated efficiently and which books or journals are to have priority while keeping equity among different departments?

This research project sets out to build/determine an analytical model that will help the library in allocating its resources to meet those different criteria. A few ways of approach follow: First, we will investigate the attributes of books/journals that are of interest. Such attributes include price, readers' evaluation, target readers, technical level and the similarity to some existing USF documents as well as the coverage to USF departments/research areas. For example, since the Arts and Sciences College has 11,000 more students than Engineering, the need for its material needs to be met without leaving out Engineering. Then, we will create a mathematical model to determine which journals/books are most beneficial given the budget. This mathematical model would provide a solution on material acquisition that maximizes our campus-wide utility. Finally, our model will be populated with real data from USF library. We will implement this with professional solvers and the results will be reported to the USF library for their usage.

Timed Verification

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Keywords: verification, LPN, model checking, POSET

As a result of the exponential increase in the number of transistors over time, verifying circuit designs by hand is not feasible and efficient algorithms are needed to verify and synthesize the reachable state space of these timed circuits. Finding and fixing errors early is of the highest priority since the cost to fix bugs increases with time. As a result of the increase in transistors and high concurrency, model checking verification suffers from *state explosion*. Because of state explosion, modern designs cannot be completely verified by a single CPU in a reasonable amount of time. Additionally, memory constraints are also limiting. The objectives of the research address state explosion and improves the effectiveness of model checking, focusing on real-time concurrent system verification by contributing timing analysis and techniques to the previous research. Model checking will be done using labeled Petri-nets (LPNs). State reduction techniques for LPNs include zoning, POSETs, and compositional verification (as a means of divide and conquer). CPU time, memory usage, and the number of states (state reduction) will measure the success of this research. The last part of the research focuses on special case optimization, such as with infinite upper bounds for Petri-net transitions.

3D Dipole Antenna for Compact Wireless Sensor Nodes

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Keywords: Dipole, Cube, 3D Antennas, Sensor Nodes, Small Antennas

In many wireless devices, antennas occupy the majority of the overall size. As compact device sizes become a greater focus in industry, the demand for small antennas escalates. In this poster a 3D electrically small dipole antenna that is directly targeted for wireless sensor nodes is presented. The 3D dipole antenna was designed using a novel method for efficiently exploiting the available volume. This method consists of fabricating the dipole on a cube configuration with opening up the internal volume for other uses. This antenna has good radiation characteristics according to its occupied volume. *K*a of this antenna is 0.55 and its measured gain is 0.86 dBi with 50% measured efficiency. Therefore, this design is very promising in low-power sensing applications. A Wheeler Cap was designed for measuring the efficiency and the 3-antenna method was used for measuring the designed antenna gain.

A Multiobjective Approach to the Relay Placement Problem in WSNs

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Keywords: Wireless Sensor Networks, Relay Placement, Multiobjective Optimization, Memetic algorithms

This poster presents a multiobjective model for the simultaneous optimization of the number of relays and the energy dissipation of a wireless sensor network meant to monitor specific locations in an area. The model is based on a hybrid evolutionary algorithm with two local searches that returns a set of efficient solutions, or Pareto front of feasible solutions. The evaluation shows that the energy can be greatly diminished by choosing one or two additional relays than the number of relays given by the minimal solution. Also, the proposed algorithm shows better approximation to the minimal number of relays than the approximation given by other algorithms in the literature.

Nonlinear Characterization of Nanoscale Barium Strontium Titanate Varactors

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Keywords: Ferroelectric, Intermodulation distortion, Two-tone measurements, Electron-beam lithography

Barium strontium titanate (BST) is a ferroelectric material with a relative permittivity that changes with respect to an externally applied electric field. Due to this characteristic along with the increase in demand of flexible RF/MW components, BST thin films have been widely investigated for the application of tunable varactors, phase shifters, and filters. For this project, we are aiming to derive a model that will accurately predict the nonlinearity of BST varactors based on the material properties of the film. Planar varactors will be fabricated using BST films with varied crystal sizes and interplanar spacing. The nonlinearity of the devices will be enhanced by creating nano-scale gaps between the electrodes using electron beam lithography. The nonlinear properties such as intermodulation distortion and harmonic generation will be observed by performing two tone measurements using a low noise floor test bench. The nonlinear model will later be used for the design of nonlinear transmission lines.

Anomaly Detection using Ensembles

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Keywords: Outliers, Anomalies, Random forests, Data partitioning, ROC curves

Anomaly detection, also known as outlier detection, deals with finding patterns in data that are unusual, abnormal, unexpected, and/or interesting. Anomalies are important because they translate to significant information that can lead to critical action in a wide variety of application domains, such as credit card fraud detection, security intrusion detection, insurance, health care, fault detection, and military surveillance.

One common method of comparing anomaly (outlier) detection approaches is to compare the areas under the receiver operating characteristic (ROC) curves. Results are shown using the areas under curve (AUC). In this poster, we investigate the use of data partitioning and ensemble methods with random forests and distance-based outlier methods for supervised learning (using class labels) of anomaly detection. We show that data partitioning and ensemble methods provide significant accuracy improvement on the same dataset.

We also investigate the use of data partitioning and ensemble methods with distance-based outlier and local outlier factor (density-based) methods for unsupervised learning (not using class labels) of anomaly detection. We show accuracy improvement over other approaches in this category as well. Significant improvement with data partitioning and ensembles is shown from the increased true positives (correct prediction of anomalies) in the low false positive (incorrect prediction of anomalies) range.

Expression Spotting in Long Videos Using Spatio-temporal Strain

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Keywords: Expression Spotting, Face Analysis, Micro-expression, Macro-expression

We propose a method for the automatic spotting of facial expressions in videos. The method utilizes the strain impacted on the facial skin due to the non-rigid motion caused during expressions. Strain magnitude is calculated using the central difference method over the robust and dense optical flow field observed on several regions (chin, mouth, cheeks, and forehead) of each subjects face. This new approach is able to successfully detect and distinguish both large expressions (macro) along with rapid and spatially specific expressions (micro). Extensive testing and experimental results have been obtained on long videos containing political debates and on long videos of 35 subjects collected by USF.

Improving the Energy Consumption in Mobile Phones by Filtering Noisy GPS Fixes with Modified Kalman Filters

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Keywords: Mathematical filters, GPS, Kalman Filter

Real-time location-based tracking applications require of continuous GPS calculations and transmissions, which consume a considerable amount of the phone's battery. As a result, methods have been devised to reduce the amount of GPS calculations and transmissions without sacrificing the tracking capabilities of the applications. One of these methods is based on a state machine that dynamically changes the frequency of GPS updates according to the user direction, speed, received signal strength, and other factors. However, the state machine, although efficient in terms of energy savings, still presents one major problem: it does not take into account the presence of noise in GPS data. In order to distinguish between actual GPS data and noise, three versions of the Kalman filter have been implemented within the state machine. These modified Kalman filters remove noisy GPS fixes with little to no input from the user in a very efficient manner. The filters are discussed in detail and tested against one another to determine which one removes GPS noise better and which one reduces the energy consumption in the cellular phone more with no loss of valuable tracking data. Experiments conducted show the Adaptive Kalman Filter as the best performer. No loss of valuable tracking data is seen while it introduces a significant decrease in the number of "asleep" fixes. The Adaptive Robust Kalman Filter is the second best performer of the three filters. It shows no loss of tracking data, while a slightly less decrease in "sleep" fixes. Testing shows that the Robust Kalman Filter is the worst performer of the three. This is because the Robust Kalman Filter is the slowest version to "wake up" and make transitions to a "sleep" state.

GO-Sync: A Framework to Synchronize Mapping Contributions from Online Communities and Transit Agency Bus Stop Inventories

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Keywords: Bus stop, General Transit Feed Specification, GTFS, location-based services, OpenStreetMap, transit agency

Most geographic data (e.g. map data) are currently either locked into proprietary formats and systems or under licensing restrictions. These limitations prevent people from sharing, viewing, or updating these data without permission from the owner or vendor, and also limit innovations in areas such as location-based services. Therefore, open-source and open-data solutions are needed. The General Transit Feed Specification (GTFS) is a common format for public transportation agencies' schedules and their geographic information for bus stops. However, transit agencies struggle to maintain and update these very large official datasets. Meanwhile, OpenStreetMap, an online free-content repository of geographic data, currently has little information about public transportation, especially in the United States, but it has a large number of users willing to freely contribute their efforts to record and improve geographic data for their communities. In this project, we create a tool for synchronizing transit data between the public transportation agency's official GTFS dataset and OpenStreetMap. The application therefore enables public transportation agencies to upload data into OpenStreetMap, where the online community can edit and correct the bus stop locations and amenities for their community. The application also enables transit agencies to retrieve this updated data so they can improve their own datasets. Successfully translating GTFS data into the OpenStreetMap format will facilitate over 110 transit agencies across the U.S. to share their public-domain data with each other, the community, as well as software developers.

Atrial Fibrillation Signal Analysis

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Keywords: Atrial Fibrillation, Time Frequency Analysis, Pattern Classification

Atrial fibrillation (AF) is the most common type of cardiac arrhythmia, a problem associated to abnormal rate or rhythm of the heartbeat. In AF, the heart's electrical signals are triggered in single or multiple locations in another part of the atria or in the nearby pulmonary veins. The signals travel abnormally propagating throughout the atria in a rapid, disorganized way causing the atria to fibrillate that eventually leads to the risk of stroke or heart failure. Current treatments such as radio frequency ablation, multiple drugs or medical procedures are successful only in 35-40% of patients. This is because of the fact that there are no methods developed to analyze the electrical activity generated by the cardiac cells during AF and to detect the aberrant atrial tissue that triggers it.

In our research, our primary objective is to identify the AF waveform characteristics which would ultimately lead to correctly locating the source triggering AF. The data will be collected from ECG as well as from the catheters which are inserted in to left atrium of the heart. The signal captured from patients suffering with AF will be processed using pattern recognition techniques. The high resolutions of the methods help in rapidly detecting the changes in frequency, regularity, waveform amplitude, and signal structure. The anticipated challenges towards reaching the goal are

1. Correctly quantifying the characteristics of the AF signal as it propagates through the tissue using the time frequency analysis.
2. Identification of AF waveforms due to single source or multiple sources.
3. Identifying signal features or characteristics by applying different signal processing techniques to accurately deduce the signal origin.

Various advanced pattern classification techniques are being applied to identify AF source which would be useful in non-invasive assessment of electrical remodeling in AF and may subsequently be helpful in locating the origin of AF or source(s) triggering AF in heart patients.

This research work is funded in part by the College of Engineering Interdisciplinary Scholarship Program.

Design and Simulation of Lumped Element Hybrid Couplers

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Keywords: Hybrid/quadrature coupler, Substrate scalable models, Bandwidth

This poster documents the design, simulation and measured results of a 2.4 GHz lumped element hybrid coupler. The size and performance of this was compared to a distributed coupler designed at the same frequency. The lumped element coupler was designed using the Modelithics CLR substrate scalable Models. It was fabricated on a FR-4 substrate with a dielectric constant of 4.3 and measured using an Agilent VNA calibrated using SOLT (8530E) calibration standards. The comparison between the simulated and measured results is presented and the size of the prototype was significantly reduced compared to a distributed version at 2.4 GHz. Results of the Montecarlo analysis are also presented to analyze the sensitivity of the circuit.

Lumped hybrid coupler is based on using high pass and low pass lumped elements and the topology of this quadrature coupler has two combinations of lumped elements and provides a high bandwidth in terms of operational frequency. It does not have any bulky via holes and can also be implemented using MMIC approach.

Delay Analysis for Opportunistic Communications in Wireless Networks

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Keywords: Delay, Throughput, Opportunistic relaying

The two-hop opportunistic relaying scheme has been proven to achieve the optimal throughput scaling in the limit of large networks. But delay related issues have not yet been addressed. In opportunistic communication, the delay may be large, since users are scheduled statistically and there is no guarantee of being scheduled within a fixed time interval. Since on average every node is afforded the same throughput, the fairness issue may be less relevant in the i.i.d. channel model, but the delay consideration is more salient and needs to be quantified. In this paper, the worst case delay performance of a decentralized two-hop opportunistic relaying scheme over channels with random connections, in which the channel connections are independent and identically distributed (i.i.d.) is considered for study. Here the worst case delay is defined as the time required for all destination nodes receiving a fixed number of packets successfully. This delay metric is of practical interest, since it is related to network efficiency. A closed-form expression of the worst case delay has also been derived. Furthermore, using simulation it is shown that the proportional fair scheduler can help reduce the delay scaling without significant performance loss on system throughput.

Graph Matching with Geometric Constraints

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Keywords: Computer vision, Graph matching, Locally affine invariant constraints, Convex optimization

Due to the rapid development of imaging technologies with increasingly higher resolution, much more attention in pattern recognition and computer vision has been paid to object matching, motion alignment and assignment problems, which become fundamental problems for many commercial, biomedical, and security applications of image processing, trajectory tracking, etc. Object matching has mostly been modeled as the matching of point graphs and further solved by mathematical programming algorithms. The objective of this study is to exploit the geometric similarity of objects represented by point graphs to improve the performance of object matching. The essential geometric properties of objects are invariant to affine transform, which composes of translation, rotation, and shear transformation. By adding the quadratic geometric similarity constraints which are invariant to affine transform, the object matching problem captures objects' geometric characteristics. We model the problem as a convex graph optimization algorithm. Because of the special structure of the quadratic geometric similarity constraints, we can directly use the results based on derivatives to obtain the optimal solution, which is not available using previous methods.

Character Energy and Link Energy Based Text Extraction in Scene Images

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Keywords: Text Extraction, Character Energy, Link Energy, Scene Image

Extracting text objects from scene images is a challenging problem. In this paper, by investigating the properties of single characters and text objects, we propose a new text extraction approach for scene images. First, character energy is computed based on the similarity of stroke edges to detect candidate character regions, then link energy is calculated based on the spatial relationship and similarity between neighbor candidate character regions to group characters and eliminate false positives. We applied the proposed approach on ICDAR dataset 2003. The experimental results demonstrate the validity of our method.

Antenna Arrays for Unmanned Vehicles

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Keywords: Omni-directional, Antenna arrays

Advancing the state of phased array technology is of national and global significance. Antenna systems are key components in most microwave communication systems, and applications for phased arrays range from medical imaging and industrial quality testing to unmanned vehicles and homeland security. This work focuses on three dimensional (3D) omni-directional antenna techniques with the ability to maintain constant elevation pointing with frequency, and provide beam-segmenting capabilities. The cylindrical arrangement of six four-element aperture coupled patch arrays using novel feeding mechanism is presented. The proposed configuration is shown to achieve optimum omni-directional beam characteristics and exhibit pattern stability over frequency in the C-band.

Research Category # 4: ***Other***

A Constructivist Approach to Teaching Probability and Statistics for Engineers

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Keywords: Constructivist Teaching, Engineering Education

This NSF funded research seeks to measure the impact of constructivist approaches to engineering education on learning outcomes. The focal course of the research is a probability and statistics for engineers course that is required for all engineering students at the University of South Florida. Instructional exercises were developed for the course that employ constructivist principles.

This poster presents preliminary data regarding feedback from students who were involved in performing these exercises. Moreover, additional data analysis contrasting the control and treatment groups is ongoing to measure differences between the two groups in terms of the following:

1) intrinsic goal orientation,

2) task value,

3) rehearsal,

4) elaboration,

5) critical thinking,

6) control beliefs about learning,

7) metacognitive self-regulation,

8) effort regulation, and

9) help seeking.

Marvel: A Miniature and Anchored Remote Robotic HD Videoscopes for Expedited Laparoscopy

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Keywords: Minimally invasive surgery (MIS), MARVEL, Wireless videoscope

This poster describes the development and construction of a wireless miniature anchored robotic HD videoscope for expedited laparoscopy (MARVEL). This device attempts to decrease the surgical-tool bottleneck experienced by surgeons in single-site procedures for minimally invasive abdominal surgery. Construction of the system includes: (1) a larger 10x20mm camera platform that will be actuated by two tiny motors giving surgeons a full range of view inside the abdominal wall, (2) a small wireless HD camera, (3) a wireless luminosity control for three different sources of light, and (4) a human machine interface to control the device. The robotic design is a proof of concept, which attempts to create a research platform for broad engineering fields at USF and surgeons in the Tampa General Hospital. This research is the first step in developing a semi-autonomous wireless laparoscopic device for minimally invasive abdominal surgery.

Heat Transfer Analysis of One-Dimension Wavy Fin Assembly with Dehumidification

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Keywords: Fully-Confined Fluid Jet Impingement, Steady State, Conjugates Heat Transfer, Heat Flux

Fin tube heat exchangers are employed in a wide variety of engineering applications such as cooling coils for air conditioning, air heaters and power stations. In general, in the heat exchangers a heat transfer medium such as water, oil, or refrigerant, flow through parallel tubes enhanced to flow while a second heat transfer fluid such as air is directed across the tubes. In the engineering application the principal resistance is much larger on the air side than that on the tube side. Therefore the surface enhanced is significant in air-cooled heat exchangers to improve the overall heat transfer performance; hence a rigid wavy surface is used to raise the heat transfer of the fin. Finned tube heat exchangers are routinely used to cool and dehumidify air. Simplified wavy finned tube geometry in this work is a logical paragon of these heat exchangers. The improvement in cooling coil efficiency provides high – performance of heating, ventilation, and air conditioning systems (HVAC). The air stream is cooled and (dehumidified) as it passes through the coils circulating the refrigerant. Heat and mass transfer take place when the coil surface temperature in most cooling coils is below the dew point temperature of the air being cooled. The combination of heat and mass transfer in cooling coils to the analytical solutions of the problem has been elaborated by considering water film resistance for a fully wet fin in dehumidifier coil operation during air conditioning. The effects of variation of cold fluid temperature (-5 to 5) ˚C, air side temperature (24 to 30) ˚C, and relative humidity (50 to 65) ˚C on the dimensionless temperature distribution and the augmentation factor are investigated and compared with those under dry conditions, for this paper the influence of heat transfer rate in the finned tube structures occurs by a set of dimensionless geometric and material parameters that have been carried out. The findings of the current work demonstrated that the overall fin efficiency is dependent on the relative humidity of the surrounding air and the angle of the fin. The fin surface area increases as a result of the fin angle increases thus resulting in better heat dissipation. Although fin angle is desirable to obtain better fin performance, there are physical limitations to build such a fin arrangement.

Spray Deposition of Bio-sensor Substrates

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Key words: Bio-assays, Wet chemistry, Antibody

A rapid technique for the fabrication of bio-assays has been developed showing similar or better results than the standard wet chemistry technique currently used. This pneumatic spray based method was investigated optimized. Deposition parameters were optimized to yield maximum performance at minimum antibody consumption. The presented experimental results demonstrate that the deposition of homogeneous antibody coatings is possible, and that detection sensitivities and reproducibility competitive with standard fabrication techniques can be achieved. Additional shelf life experiments showed that similar lifetimes are achieved compared to wet chemistry techniques.

Creation of a Robotic Upper Body Model Using Functional Joint Center Methods

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Keywords: Rehabilitation, Prosthetics, Human Modeling, Kinematics

The analysis of biomechanical systems requires accurate modeling of the human body. Functional joint centers have been shown to produce accurate locations of joints in anatomical structures. This work shows the creation of an upper body model generated from motion analysis data using functional joint center calculations. The human body is divided into ten segments: the pelvis, the torso, scapulas, upper arms, forearms, and hands. The path of markers placed on a distal segment were then tracked relative to a proximal coordinate system, and analyzed to find the best fit center of rotation. The joint center information was then used to find the parameters of an equivalent manipulator composed of one degree of freedom joints. This series of joints were described by the robotic parameters described by Denavit and Hartenberg (DH paramerters). Future work will implement this model in to a predictive simulation of the upper body during activities of daily living.

Development of Flexible-Rigid Hybrid Body Armor

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Keywords: Finite element analysis, body armor, composite, ANSYS AUTODYN

To stop projectiles and absorb the energy of the impact, current military-grade body armors use ceramic plates positioned on top of composite material layers. However, absorbing the impact energy and stopping the projectile comes at a cost to the wearer – low mobility.

In this poster a new concept of a flexible-rigid hybrid body armor is presented. The hybrid armor combines the flexibility offered by soft Kevlar based armor with the protection of a hard ceramic plate armor. This is achieved by using a matrix of specially designed ceramic plates each held in place over a layout of Kevlar sheets by a flexibly rig. This hybrid armor system offers the wearer an optimal balance of mobility and protection against many assault rifle projectiles, such as the 7.62mm Soviet round.

In this poster, we demonstrate the use of finite element methods to analyze the stress as well as the energy absorption of each component (including the wearer) of the hybrid armor system while being impacted by a high-speed projectile. Finite element analysis is also used to determine the layer condition (failed or safe) immediately following the impact.

To the authors' best knowledge, no similar hybrid body armor system is currently in production or being researched.

Pseudo-Rigid-Body Model for Initially Straight Spatial Compliant Mechanisms

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Keywords: Compliant mechanisms, Spatial kinematics, PRBM

This poster presents the Pseudo-Rigid-Body-Model for initially straight spatial compliant mechanisms. The pseudo-rigid-body model (PRBM) is a simple method of analyzing compliant mechanisms systems that undergo large, nonlinear deflections. It is a simplified form used to model the deflection of flexible members by using rigid-body joints that have the equivalent force-deflection characteristics. The PRBM predicts the deflection path and force-deflection relationship of flexible segments, modeling them as rigid links attached at the pin joints. Springs are added to predict the force-displacement relationship of the flexible members. A procedure for approximating the deflection of a cantilever beam thru kinematic equations was developed. By means of the kinematic equations, the formulation of the PRBM for initially straight spatial compliant mechanisms was performed. The PRBM predicted the deflection of the tip end of different models. The result shows an error at the end tip of 2% compared with the Finite Element Analysis model.

Remote Controlled Multi-directional Rotating Platform for Stage Performances

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Keywords: Dance, Robotics, Platform, Omni-directional, Rehabilitation, Engineering

This project involves the design and development of a multi-directional platform with an independently rotating top to be used onstage during theatrical and dance performances. The project is the result of collaboration between the University of South Florida's College of The Arts (Merry Lynn Morris, MFA) and the Center for Assistive, Rehabilitation and Robotics Technologies (Mechanical Engineering). The problem has been to development a robust, remote controlled, compact, transportable, and inexpensive moving platform with a rotating top. This platform adds an additional choreographic element to Ms. Morris' unique style of dancing, which involves the use of a variety of mobility devices and performers including dancers with disabilities. The platform is designed to hold up to five-hundred pounds with an independently rotating top while the base moves forward/backward, sideways, or diagonally. The top of the platform is driven by a compact gear train designed to deliver maximum torque within a limited space. The control system design utilizes two wireless remotes for on and off-stage use, working in conjunction with an onboard processor and ultrasonic sensors to operate the rotating top and bottom drive system. The current control and drive system designs will be presented in this poster.

Modifications to the Hands-Free Wheelchair for Dance: Kinetic Armrest Prototype

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Keywords: Design, Wheelchair, Choreography, and Human Factors

The University of South Florida created an interdisciplinary team between the Department of Mechanical Engineering and the School of Theatre and Dance to build innovative, mobile devices for the Performing Arts. The fabrication of the Hands-Free Wheelchair has generated unique choreography between the wheelchair user and other dancers. It is operated and controlled by weight-shift change in the seat. In order to keep this control "hands-free", while giving the user a sense of stability, kinetic armrests have been designed for both assistance and use as a dance tool. This design incorporates anthropomorphic data, engineering design, and the five basic arm positions of dance into a final prototype. The armrests can withstand 200 lbs of static loading and can rotate 180 degrees in the vertical and horizontal planes. Its wide range of motion also includes length changing capabilities and quick-release locking mechanisms. This presentation discusses the prototype and Human Factors involved in this essential upgrade.

Flame Ionization Detection (FID) Response Factors for Chlorinated Ethenes in Water Samples

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Keywords: Flame Ionization Detection (FID), Response Factors, Calibration Plot

Chlorinated ethenes are among the most common environmental contaminants and are known or suspected carcinogens. This class of compounds includes perchloroethene (PCE), trichloroethene (TCE) and their breakdown products, including dichloroethene isomers, vinyl chloride, and ethene. Engineers and scientists must be able to measure concentrations of these chemicals in water samples to assess site contamination, monitor clean-up progress, and test possible remediation technologies.

Gas chromatography with flame ionization detection (GC/FID) is the most common method for measuring these contaminants in environmental samples. To use this method, we must first calibrate the GC/FID instrument. Historically, the instrument must be calibrated for each of the chemicals individually. Developing plots for each compound is time intensive and requires a significant number of sample runs. However, we hypothesize that the FID response factors for all chlorinated ethenes are the same. When the peak area obtained from the GC/FID was plotted versus the molar concentration in the gas phase, a linear regression was produced with an R^2 value of 0.982. Since these calibration lines coincide, only two chemicals must be tested to derive plots for all other target chemicals, simplifying the experimental procedure and reducing analysis time.

Analyzing Force Platform Calibration with a Novel Pole Design

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Keywords: Center of Pressure; Inverse Dynamics, Rehabilitation Engineering

Analyzing a person's gait is an important tool in the diagnosis of movement disorders, the fine-tuning of athletic performance, and the analysis of prosthetic design and function. 3D motion analysis systems frequently combine the use of motion capture cameras and force platforms (FP) to capture kinematic and kinetic data. Inverse dynamics can then be used to find forces and moments at specific joints in the subject's body. In order for these outcomes to be accurate, it is essential that the motion analysis systems are calibrated properly to ensure the raw data are accurate. This poster reports on a new spring-loaded pole used to determine and minimize the error in force and center of pressure (CoP) data of force platforms in motion analysis systems. The spring-loaded pole consists of two short segments of polyvinylchloride (PVC), a universal joint, two springs, a rubber tip, and a handle. To test the motion analysis system, the operator used the pole to manually apply a force to the FP. Motion cameras track the orientation and deflection of the pole, which is then used to calculate the force vector along the pole's long axis. This calculated force vector is then compared to the force information from the FP to analyze the calibration of the system. This spring-loaded pole improves previous instrumented pole designs by replacing expensive force transducers with an inexpensive spring, allowing for a quick analysis of a system's performance and calibration.

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