November 2, 2016

Dear Research Day Participants,

Welcome to the 9th Annual USF Engineering Research Day! We are pleased to highlight the groundbreaking research of graduate students and undergraduates completed both within our College and with collaborators on the USF campus (College of Arts & Sciences, Morsani College of Medicine, H. Lee Moffitt Cancer Center & Research Institute, and others). This year, our presenters are from nearly 50 undergraduate institutions within 30 countries.

In addition to celebrating the research progress of our students and faculty mentors, we would like to congratulate John Kuhn (Chemical & Biomedical Engineering), Yao Liu (Computer Science and Engineering) and Qiong “Jane” Zhang (Civil and Environmental Engineering) on their selection as recipients of the 2016 College of Engineering Outstanding Research Achievement Awards. Annually, the Outstanding Research Achievement Awards honor COE faculty who have made scholarly accomplishments of national and international distinction that elevate the standing of our College. We also want to recognize all of our faculty who were honored this past year for their, teaching, research and mentoring accomplishments.

We would like to express our appreciation to the USF Office of Research & Innovation, and the Alfred P. Sloan Foundation University Center for Exemplary Mentoring for their continued financial support of Research Day. Also, we are grateful for our student volunteers and ambassadors from the USF Student Chapters of the Society of Hispanic Professional Engineers (SHPE), and the National Society of Black Engineers (NSBE).

In closing, we wish to thank our students for preparing nearly 100 posters as well as faculty mentors, collaborators, and research centers for their efforts in training the next generation of engineers, researchers, innovators, and professionals. Nobel Laureate Albert Einstein once wrote “learn from yesterday, live for today, hope for tomorrow. The important thing is not to stop questioning.” As a College, we are committed to this quest by shaping and impacting lives through world-class engineering research and education. We look forward to celebrating your work during Research Day.

Sincerely,

Research Day Organizing Committee 2016
College of Engineering Leadership Team

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

Jose Zayas-Castro, Ph.D., FIIE
Professor & Executive Associate Dean

Fred Mannering, Ph.D.
Professor & Associate Dean for Research
CHEMICAL & BIOMEDICAL ENGINEERING

Vinay K. Gupta, Ph.D.
Interim Chair, Professor and Graduate Program Coordinator

Norma A. Alcantar, Ph.D.
Professor & Director, Graduate Certificate in Water, Health & Sustainability

Venkat Bhethanabotla, Ph.D.
Director of Materials Science and Engineering & Professor
Biosensors, Plasmonics, Computational Catalysis, Cardiac Electrophysiology Modeling.

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

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

David Eddins, Ph.D.
Interdisciplinary Professor

Robert Frisina, Ph.D., ASA, AIMBE
Professor, Director of the Biomedical Engineering Program

Nathan Gallant, Ph.D.
Interdisciplinary Professor
Biomechanics, Cell adhesion, Biomaterials, Tissue engineering, Surface functionalization, and Micropatterning.

Richard Gilbert, Ph.D.
Professor
Biomedical systems, Electrochemotherapy, Instrumentation, Drug delivery, and Engineering Education.
Yogi Goswami, Ph.D., AAAS, ASME, NAI, ASES  
Distinguished University Professor & Co-Director, Clean Energy Research Center  
Energy conversion, Solar energy, Hydrogen energy and Fuel cells, Thermodynamics and Heat transfer, and HVAC.

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

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

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

John Kuhn, Ph.D.  
Associate Professor  

William E. Lee III, Ph.D., PE  
Professor  
Biomechanics, Prosthetic Design, Creative Processes, Education.

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

Sandy Pettit, Ph.D., PE  
Instructor II  
Pedagogy and Engineering Education

Anna Pyayt, Ph.D.  
Assistant Professor  

Alberto A. Sagues, Ph.D., P.E., NACE  
Interdisciplinary Professor  
Carlos A. Smith, Ph.D., PE  
Professor Emeritus  
Automatic process control, Dynamic process modeling, and Process engineering.

Aydin K. Sunol, Ph.D., PE  
Professor  
System engineering, Supercritical fluid technology, Green engineering, and Product and process design.

Ryan Toomey, Ph.D.  
Associate Professor  
Material science, Polymer thin films, Hydrogels, Molecularly imprinted materials, and Holographic Polymerization.

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

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

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

Mauricio E. Arias, Ph.D.
Assistant Professor
Food-water-energy systems and sustainable water management in the Global South; climate change and water resources development; ecohydrology of wetlands; ecological engineering for water management/treatment and ecological restoration; hydro-ecological effects of hydropower.

Robert L. Bertini, Ph.D., PE
Professor and Director of Center for Urban Transportation Research (CUTR)
Sustainable transportation solutions, Traffic flow theory informed by empirical and experimental measurements, Intelligent transportation systems, Multimodal transportation "big data" for improving performance measurement, planning and operations, Proactive traffic management.

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

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

Sarina J. Ergas, Ph.D., P.E., WEF
Professor and Graduate Program Director
Environmental biotechnology, Biological treatment processes, Nutrient recovery, Water reuse, Low impact development technologies, Sustainable algal biofuel systems.

Stanley C. Kranc, Ph.D., P.E.
Professor Emeritus
Experimental and theoretical fluid mechanics, Numerical analysis, Corrosion of reinforcing steel in concrete, Magnetofluidmechanics and electrohydrodynamics, Transport processes, Multiphase flow and heat transfer, Chemically reacting flow and combustion, and Physics of high temperature gases.
Xiaopeng "Shaw" Li, Ph.D.
Assistant Professor
Transportation engineering, Connected automated traffic analysis and control, Sustainable infrastructure systems design, and Sensor networks.

Qing Lu, Ph.D.
Assistant Professor
Pavement engineering, Asphalt mix design, Pavement management system, Transportation infrastructure management, Steel bridge deck surfacing

Fred L. Mannerling, Ph.D.
Professor & Associate Dean for Research
Statistical and econometric methods, highway safety, transportation economics, automobile demand, and travel behavior.

James R. Mihelcic, Ph.D., BCEEM, AAEE, WEF
Samuel L. and Julia M. Flom Professor, State of Florida 21st Century World Class Scholar, Director, Master’s International Program in Civil & Environmental Engineering, Director, EPA Center for Reinventing Aging Infrastructure for Nutrient Management
Sustainability, Impact of anthropogenic stressors on water resources, Water supply and reuse, Nutrient management, Water/sanitation/hygiene (WASH) in the developing world, Engineering education.

Gray Mullins, Ph. D., P.E.
Professor

Mahmood H. Nachabe, Ph.D., P.E., ASCE
Professor
Hydraulics & water supply systems, Soil & ecosystem hydrology, Flow & contaminant transport in porous media, Stochastic hydrology.

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

Abdul Pinjari, Ph.D.
Associate Professor
Transportation planning & travel demand forecasting, Choice modeling, applied econometric analysis, Freight transportation & logistics, Land-use & transportation interactions, Sustainable transport, energy & environment, Transportation safety.

Steve E. Polzin, Ph.D., P.E.
Director, Mobility Policy Research, Center for Urban and Transportation Research (CUTR)
Public transportation, Systems evaluation, Transportation planning, Planning process design, Policy analysis, Mobility needs analysis, Travel behavior, Economic impacts
Mark Ross, Ph.D., P.E.
Professor
Water resources, Hydrologic hydraulic, and water quality modeling, Surface and groundwater interaction, GIS applications in hydrology, lake and estuary water quality management, and Estuary sediment dynamics.

Amy Stuart, Ph.D.
Associate Professor
Air pollution, Atmospheric chemistry, Environmental computational modeling, Urban design & human exposure to transportation emissions.

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

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

Daniel Simkins, Ph.D.
Associate Professor
Computational mechanics, Numerical analysis, Composite materials, Computational engineering

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

Andrés E. Tejada-Martinez, Ph.D.
Associate Professor
Numerical simulations of turbulent flows; vertical turbulent mixing in the upper ocean and coastal shelves; mixing/hydraulic efficiency of water and wastewater treatment systems; finite element, finite difference and spectral methods for fluids; parallel computing.

Maya A. Trotz, Ph.D.
Associate Professor
Sustainability, Water quality, Ecotourism & small scale mining impacts on sustainable livelihoods, Climate change, Environmental engineering education in formal & informal settings in the US and in developing countries.

Daniel H. Yeh, Ph.D., P.E., LEED AP
Associate Professor
Water purification, wastewater resource recovery and life support in challenging, off-grid and remote environments; Autonomous, self-powered water machines; Anaerobic and phototrophic membrane bioreactors; Food-to-food (F2F) biorecycling; Innovations at water-energy-food nexus.
Abla M. Zayed, Ph.D.
Associate Professor
Materials engineering and mechanical performance of concrete, metals and composites.

Qiong “Jane” Zhang, Ph.D.
Associate 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.
Associate Professor
Air transportation, Transportation network modeling and operations, Transportation economics and planning, Freight transportation, and Transportation Sustainability.
COMPUTER SCIENCE & ENGINEERING

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

Fathi Amsaad, Ph.D.
Visiting Instructor
Cyber security and cyber-physical systems; Embodied systems; ASICs / FPGAs security; Digital / VLSI systems testing

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

Sriram Chellappan, Ph.D.
Associate Professor
Socio-technical systems; Cyber security; Smart health; Mobile networking; Cyber-Physical Systems.

Alessio Gaspar, Ph.D.
Associate Professor

Harry Glass, Ph.D.
Professor Emeritus
Operating systems, programming languages, Embedded systems design.

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Professor
Motion analysis, Computer Vision, Image Processing & Biomedical Applications, and Pattern Recognition.

Larry Hall, Ph.D., IEEE, IAPR, AAAS
Distinguished University Professor
Intelligent systems, Machine learning/data mining, Fuzzy logic in intelligent systems, and Artificial intelligent in visual pattern recognition.

William Hendrix, III, Ph.D.
Instructor
Graph algorithms; Graph mining; Parallel algorithms; Real-world applications modeled as large-scale networks.

Isabela M. Hidalgo, Ph.D.
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Human-Computer Interaction and Programming Languages.
Adriana Iamnitchi, Ph.D. Associate Professor
Large-scale distributed systems, Grid computing, and Peer – to –peer networks.

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Instructor
Technical analysis algorithm; Optical Character Recognition.

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

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

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Associate Professor
High level synthesis, Low power synthesis, Radiation VLSI design, and CAD.

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Computer Vision, Imaging Processing, and Pattern Recognition.

Miguel Labrador, Ph.D.
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Design and evaluation of transport layer protocols; Wireless ad hoc and sensor networks; Bandwidth estimation techniques; Location-based sensing systems; Ubiquitous sensing; Computer networks.

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

Yao Liu, Ph.D.
Assistant Professor

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Associate Professor
Cyber security, Cyber physical systems, Programming languages, Cloud computing, Human aspects of computing.

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Artificial intelligence, Neutral networks, and Genetic algorithms.
Les Piegl, Ph.D.
Professor
Geometric algorithms, Computer-aided design, Geometric modeling, Computer graphics and analysis.

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VLSI system design, VLSI design automation power estimation and optimization computer architecture, and Heterogeneous computing bioinformatics.

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

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Professor & Associate Vice President for Research & Innovation
Computer vision and image analysis; Automated sign language; Recognition biometrics and human and human identification; Perceptual organization for grouping and segmentation; Bayesian methods.

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Robotics, Haptics, Computer vision, Human computer interaction (HCI), and Medical robotics.

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

Yicheng Tu, Ph.D.
Associate Professor
Database systems; Multimedia systems; Distributed systems.

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

Jing Wang, Ph.D.
Instructor
Computer animation; K-12 outreach; Undergraduate computer science and engineering education.

Alfredo Weitzenfeld, Ph.D.
Professor
Yan Zhang, Ph.D.
Instructor
Computer Science Education

Hao Zheng, Ph.D.
Associate Professor
System verification and validation; High-performance computing.
ELECTRICAL ENGINEERING

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

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

Sanjukta Bhanja, Ph.D.
Professor and Associate Dean for Academics and Student Affairs
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.

Robert Bishop, Ph.D., P.E., AIAA, AAS
Professor and Dean, College of Engineering
Advanced navigation algorithm development with fast-to-flight characteristics, integrated navigation and guidance for planetary precision landing, small satellites and unmanned aerial vehicles.

Kenneth Buckle, Ph.D., P.E.
Professor Emeritus

Alexandro Castellanos, Ph.D.
Instructor
Cyber physical systems, embedded systems, Internet of things (IoT) and control theory for industrial applications in the areas of Mechatronics and Industrial Automation.

Morris Chang, Ph.D.
Professor
Computer and wireless networking systems, with recent emphasis on cybersecurity: Attribution, Program Analysis for cybersecurity and privacy-preserving Internet Computation; Energy-aware mobile and cloud systems; Energy-efficient wireless networks.

Kwang-Cheng Chen, Ph.D., IEEE
Professor
Information communication technology essential to digital society, particularly in large networks and computations. Specific interests include large communication networks: Internet of Things, Cyber-Physical Systems and Edge Computing, 5G Mobile Communications and Beyond, Ad Hoc Sensor Networking, In-Network Computations and Approximate Computing, Cognitive Radio Networks, Secure Communications and Resilient Networks; Large Information Networks: Social Networks, Big Data
Analytics, Multi-Agent Systems and Collective Behavior, Fusion and Decision on Heterogeneous/Multimodal Data, Biochemical Reaction Networks and Applications to Synthetic Biology and Systems Biology, Decision under Uncertainty, and Cybersecurity and Privacy.

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

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

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

Christos Ferekides, Ph.D.
Professor
Study and development of electronic materials and devices for opto-electronic applications such as solar cells, light emitting diodes, and x-ray detectors.

Nasir Ghani, Ph.D.
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Cyberinfrastructure design, networking, disaster recovery, cloud computing, and cyber-physical systems (integrated power grids).

Richard Gitlin, Sc.D., NAE, NAI, IEEE
Distinguished University Professor, Agere Systems Chair, State of Florida 21st Century Scholar
Communications and networking systems for wireless and wired media; Wireless networking of intelligent bio-medical systems, with an emphasis on advanced communications and network protocols to realize high-speed and ultra-reliable in vivo wireless networks intended to create a paradigm shift in disciplines such as minimally invasive surgery, cyber-physical healthcare systems, and sensor networks.

Andrew Hoff, Ph.D.
Professor & Graduate Program Coordinator
Afterglow chemical processing of materials for electronics, sensor, and MEMS applications; Oxide formation on Si & SiC, Diamond processing, Surface Conditioning, Noncontact Corona Kelvin Metrology of electronic materials; Dielectrics, SiC, Corona Ion-Assisted delivery of drugs and DNA to Skin and Tissue, Noncontact voltage and corona characterization of cells and tissue, Contamination monitoring and control in IC Manufacturing, Microsystem and MEMS fabrication, Integrated Circuit manufacturing and in-line testing, and Workforce development and training for technology professionals.
Vijay Jain, Ph.D.
Distinguished University Professor
Biomedical systems, biomedical imaging and biomedical image processing, Communication systems and networks, Digital image and video processing, VLSI implementations, system on a chip (bio-sensing, DNA microarrays, opto-electronics, MEMS, digital, analog), and 3-D SOCs.

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

Selcuk Kose, Ph.D.
Assistant Professor
Broad field of integrated circuits and VLSI systems, with a primary emphasis on circuit design techniques, power grid analysis algorithms, mathematical methods to characterize power grids, power delivery challenges in 3-D integrated circuits, noise issues in on-chip interconnection networks, design and analysis of clock distribution networks, and resistive memories.

Zhuo Lu, Ph.D.,
Assistant Professor
Network science, cyber security, data analytics, wireless and mobile communication networking, and cyber-physical systems.

Zhixin Miao, Ph.D.
Assistant Professor
Smart grid automation, electrical power system modeling and simulation, microgrid technologies to integrate renewable energy and energy storage, and power markets.

Don Morel, Ph.D.
Professor
Renewable energy, Photovoltaic solar energy with particular emphasis on the development of thin film solar cells of CuInGaSe2, CdTe and CdSe, amorphous Si, and organic materials, Transparent conductors including ZnO, SnO2, High efficiency thin film tandem solar cells, Photovoltaic device modeling and simulation, Photodetectors, thin film transistors and memory devices, LED’s, and x-ray and gamma ray detectors, I-III-VI2 and II-VI materials and devices.

Wilfredo Moreno, Ph.D.
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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 VOIP applied to Distance Learning

Salvatore Morgera, Ph.D., P.E., FIEEEE, AAAS,
Professor
Biomedical engineering, secure telecommunications networks-biometrics for Identity Management in a Wireless Networked Environment.; high performance computing; and design and implementation of internet based control systems.
**Gokhan Mumcu, Ph.D.**
Associate Professor
Electromagnetic theory, computational electromagnetics, THz imaging systems, metamaterials and their applications to small directive radiators and printed miniature antennas.

**Al-Aakhir Rogers, Ph.D.**
Courtesy Professor
Novel development of optical MEMS sensors.

**Stephen Saddow, Ph.D.**
Professor
Wide-band gap semiconductor materials for high-field and high-power device applications, specifically SiC for Bio, Nano and MEMS applications.

**Ravi Sankar, Ph.D.**
Professor
Wireless communications, networking, and signal processing and its applications, Resource and mobility managements of wireless cellular, Ad-hoc, and sensor networks, Energy-efficient design and cross-layer optimization, processing, coding, and recognition applications to speech, image, biomedical and other signals and in integrating intelligent techniques including the use of neural networks and fuzzy logic in the simulation, modeling, and design of high performance and robust systems.

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

**Arthur David Snider, Ph.D.**
Professor Emeritus
Mathematical Modeling in Physics and Engineering, Numerical Analysis, Differential Equations, Optimization

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

**Arash Takshi, Ph.D.**
Associate Professor & Director of Undergraduate Research, College of Engineering
Bio and Organic electronic devices, particularly in photovoltaic devices.
Sylvia W. Thomas, Ph.D.
Associate Professor
Advanced materials for alternative energy sources, sustainable environments, aerospace, and bio-applications from the micro to the nano scale, characterizing, modeling, and integrating materials that demonstrate high levels of biocompatibility, thermal reflectivity, mechanical robustness, and environmental sustainability, such as carbides, sol-gel coatings, high temperature oxides, and mucilage.

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

Jing Wang, Ph.D.
Associate Professor
Nano/microfabrication, Nanomaterials, RF MEMS devices, On-chip power generation, Microfluidics, MEMS transducers, RF integrated circuit, Wide bandgap materials, Polymer nanocomposite, and Responsive polymers.

Thomas Wade, Ph.D.
Professor Emeritus
Engineering Education

Paris Wiley, Ph.D.
Associate Professor & Associate Chair

Yasin Yilmaz, Ph.D.
Assistant Professor
Statistical data and signal analysis, machine learning, multimodal data fusion, event-driven systems, object-oriented modeling, and sequential analysis with applications in cybersecurity, big data, social networks, smart grid, smart city and intelligent transportation systems, autonomous driving, wireless communications, IoT, and cyber-physical systems.
INDUSTRIAL AND MANAGEMENT SYSTEMS ENGINEERING

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

Shikhar Acharya, Ph.D.
Visiting Instructor
Applying component analysis and Markov modeling to detect malicious electronic devices using their unintended electromagnetic emissions, Engineering Education.

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

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

Hadi Charkhgard, Ph.D.
Assistant Professor

Changhyun Kwon, Ph.D.
Associate Professor
Risk management in transportation systems, integrated transportation approaches, and operations management in sustainable transportation systems.

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

Mingyang Li, Ph.D.
Assistant Professor
System informatics and data analytics with their applications in reliability, quality, energy, homeland security, manufacturing, etc.

Geoffrey Okogbaa, Ph.D.
Professor
Reliability, Maintainability, Engineering design, Automated manufacturing systems, and Quality Control.
**Kingsley Reeves, Ph.D.**  
Associate Professor  
Supply chain management, Organizational structure, Collaborative networks, and Managerial decision making in outsourcing.

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

**Paul Schnitzler, Ph.D.**  
Instructor  
Management of technological change motivation, and the development of individual creativity for the benefit of organizations.

**Michael Weng, Ph.D.**  
Associate Professor  
Computer numeric methods, Production control, Operations research, and Material resource planning.

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

**Jose Zayas-Castro, Ph.D., IIE**  
Professor & Executive Associate Dean  
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.
MECHANICAL ENGINEERING

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

Glenn Besterfield, Ph.D.
Associate Professor, Assistant Vice President, International Admissions & Global Partnerships,
Finite Element Analysis, Computational Mechanics, Mechanical Design, Bascule bridges.

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

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

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

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

John Dixon, Ph.D.
Instructor

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

Jonathan Gaines, Ph.D.
Instructor

Nathan Gallant, Ph.D.
Associate Professor
Biomechanics, Cell adhesion, Biomaterials, Tissue engineering, Surface functionalization, and Micropatterning.
Rasim Guldiken, Ph.D.
Associate Professor & Graduate Program Advisor
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 & Undergraduate Advisor
Dynamics of mechanical & structural systems with friction, Machinery dynamics & diagnosis, and Mechanical design.

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

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

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

Ajit Mujumdar, Ph.D.
Assistant Professor
Fluid Mechanics, Animal Biomechanics, Oil Spills

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

Frank Pyrtle III, Ph.D., P.E.
Instructor
Two-phase heat transfer, Droplet and spray cooling, Micro/nano scale heat transfer, Microelectronic device thermal management, and Engineering education.

Kyle Reed, Ph.D.
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Rehabilitation engineering, Haptics, Human-machine interaction, Medical robotics, and Engineering education.

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

Shuh Jing Benjamin Ying, Ph.D.
Professor Emeritus

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

*NSF Graduate Research Fellowship Program (GRFP)*
Laura Byrnes-Blanc
Shamara Collins
Joel Cooper
Francisca Moloney

*NSF East Asian Pacific Summer Institute Fellowship (EAPSI)*
Joel Cooper

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

*NASA Florida Space Grant Consortium (FSGC) Dissertation/Thesis Improvement Fellowship*
Nada Elsayed
Michelle Henderson
Laura Rodriguez-Gonzalez

*UNCF Gates Millennium Scholarship (GMS)*
Dagmara Monfort

*Draper Laboratory Fellowship (DLF)*
Tylar Murray

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

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

*USF Presidential Fellowship*
Arseny Zhdanov
Wieze Yu

*National Consortium for Graduate Degrees for Minorities in Science and Engineering (GEM) Fellowship*
Maya Carrasquillo
Shamaria Engram
Michael Grady
Jayrick Hayes
Troi Williams

*Florida Education Fund’s McKnight Doctoral Fellowship Program*
Maya Carrasquillo
Evans Bernardin
Shamara Collins
Michelle Henderson
Nicole Febles
Tamina Johnson
Florida Education Fund’s McKnight Doctoral Fellowship Program
Dagmara Monfort
Michael Grady
Laura Rodriguez-Gonzalez
Kiesha Pierre
Rasheda Toomer
Tanika Williamson
Andrea Patrice Wright

USF Graduate Student Success Fellowship
Nada Elsayed
Amine Hafsi
Laura Rodriguez-Gonzalez
Lorena Sanchez
Antonia Panaou

USF University Fellowship
Anique Akhtar
Natalia Maria Barbour
Zulqarnain Haider
Xiaoshan Wang

USF Signature Research Fellowship
Fabiola Araujo Cespedes
Pacia Hernandez

USF Dissertation Completion Fellowship
Adrian Avila
Di Lan

Schlumberger Foundation Faculty for the Future Fellowship
Fabiola Araujo Cespedes

Alfred P. Sloan Minority Ph.D. Fellowship Program/University Center of Exemplary Mentoring (UCEM)
Ilia Bauista-Adames
Jorge Adorno Niev
Ufumaroghene Ikoba
Michelle Henderson
Mariyah Pressley
Rasheda Toomer
Maya Carrasquillo
Emma Lopez
Pacia Diaz
Nicole Febles
Christopher Slater
Jorge Calabria
Andrea Patrice Wright
Laura Rodriguez-Gonzalez
College of Engineering Graduate Fellowship Recipients

Alfred P. Sloan Minority Ph.D. Fellowship Program/University Center of Exemplary Mentoring (UCEM
Tamina Johnson
Michael Grady
Amine Hafsi
Rafael Rodriguez

NSF FGLSAMP Bridge to the Doctorate Fellowship
Ilia Bautista Adames
Evans Bernardin
Shamara Collins
Shamaria Engram
Michelle Henderson
Francesca Moloney
Steven Diaz-Hernandez
William Serrano-Garcia
Nicole Febles
Tamina Johnson
Troi Williams
Jayrick Hayes
Marilyah Pressley
Rasheda Toomer

U.S. Student Fulbright Research Grant Scholarship
Pacia Diaz

WaterRuse Florida Scholarship
Antonia Panaou
9th Annual USF College of Engineering Research Day

USF Marshall Student Center Ballroom
Wednesday, November 2, 2016

AGENDA

8:45 a.m. – 9:15 a.m.  Poster Set-up
                      Students arrive and check in

9:15 a.m. – 9:30 a.m.  Robert H. Bishop, Ph.D.
                      Dean, College of Engineering
                      Welcome and introduction of Jose Zayas-Castro

Jose Zayas-Castro, Ph.D.
Executive Associate Dean, College of Engineering
Opening Remarks
Announcement of COE Faculty Research Award Recipients

Junior Awards
Qiong Zhang, Ph.D. - Civil and Environmental Engineering
Yao Liu, Ph.D. - Computer Science and Engineering

Senior Award
John Kuhn, Ph.D. - Chemical and Biomedical Engineering

9:30 a.m. - 11:30 p.m.  Poster Viewing and Judging

11:30 a.m. - 12:30 p.m.  Buffet Lunch & Recognition of Guests

12:00 p.m.  Sudeep Sarkar, Ph.D.
            Professor & Associate Vice President for Research and Innovation

12:30 p.m. – 1:00 p.m.  Poster Removal
Welcome

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

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

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

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

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

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

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

Sudeep Sarkar, Ph.D. is a professor of Computer Science and Engineering and Associate Vice President for Research & Innovation at the University of South Florida at the University of South Florida. He received his M.S. and Ph.D. degrees in Electrical Engineering, on a University Presidential Fellowship, from The Ohio State University. His major accomplishments at Research & Innovation include development of a program to further USF’s national reputation by fostering faculty nominations for honorific awards and prizes. Because of his efforts, USF now ranks fourth in world in AAAS Fellows. He also led the development of the NSF grant for a USF I-Corps Site which has brought national and international recognition to USF, which currently ranks third in the United States with 21 NSF I-Corps Teams trained at the national level. Most recently, he served as co-chair of the Research Strategic Planning Committee that ultimately engaged 550 faculty, staff and community members. As Chair, Dr. Sarkar will continue his work as co-PI on the NSF I-Corps grant.

Dr. Sarkar has more than 25 years of experience conducting and directing fundamental and applied research in computer vision, image processing, and pattern recognition related topic. His research topics ranged from video image processing to biometrics and medical image analysis of burn scars. With series of funding from the National Science Foundation, he has made seminal algorithmic and theoretical contributions to the field computer vision, particularly in the problem of computing perceptual organization, sign language recognition. Dr. Sarkar has numerous awards for research and teaching excellence, including the NSF CAREER Award (1994), USF Teaching Incentive Program Award for Undergraduate Teaching Excellence, the USF Outstanding Undergraduate Teaching Award, and the Theodore and Venette Askounes-Ashford Distinguished Scholar Award.

Dr. Sarkar currently leads major grants as PI or Co-PI, totaling nearly $2 million from NSF, DOD and U.S. Department of Commerce. He serves on the boards of nearly two dozen national and state boards and councils, as well as many program committees. He is co-editor-in-chief for Pattern Recognition Letters, and is associate editor or member of the editorial board of several other national scholarly journals. He is a Fellow of the American Association for the Advancement of Science (AAAS), Institute of Electrical and Electronics Engineers (IEEE), American Institute for Medical and Biological Engineering (AIMBE), and International Association for Pattern Recognition (IAPR); and a charter member and Board of Directors member of the National Academy of Inventors (NAI).
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## Research Category # 1

**ENERGY, SUSTAINABILITY, WATER AND INFRASTRUCTURES/TRANSPORTATION**

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SENSING, NETWORKING, COMMUNICATIONS, COMPUTING, BIOMETRICS AND PATTERN RECOGNITION

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**Research Category # 4**

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Research Category # 1: Energy, Sustainability, Water and Infrastructures/Transportation
Pedestrian and Bicycle Crash Typing

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Keywords: Crash Typing, Pedestrians, Bicyclist, Hotspots, Road Safety

The State of Florida witnessed a 29% increase in fatal crashes from 2014 to 2015, which was more than twice the national average, leading to a total of 18,630 fatal crashes nationwide within the first six months. As per statistics from Department of Highway Safety and Motor Vehicles (DHSMV) Annual Report 2014, there were an average of 943 crashes per day only in Florida in 2014, with an 8.64% surge from previous year with 15,915 being purely pedestrian and bicyclist crashes. Thus, it is no exaggeration when we infer how grave an issue pedestrian and bicycle safety has become.

Our ongoing research project aims to crash type and thus analyse crashes to help traffic safety specialists, traffic engineers, planners, and law enforcement personnel ultimately reduce the numbers and severity of crashes on our roadways based on predicting trends and rectifying causes that lead to them. Thus far our team has completed crash typing of pedestrian and bicycle crashes provided by the Florida Department of Transportation (FDOT) for 2010-2014. Crash Typing involves manually entering data, based on crash reports that are made available by the Law Enforcement Agency submitting the crash report. The team has been using industry standard software tools namely PBCAT (Pedestrian and Bicyclist Crash Analysis Tool) and Signal Four Analytics 3.0 for this effort. At our analysis stage this data will be an aid towards recognizing the hotspots in the area, i.e. places where most crashes occur, faults on the end of those involved in the incident, or maybe even deficits in properly maintaining standard crosswalks/lighting among other things in the vicinity. This research aims to provide the necessary detailed information to policy makers and engineers to influence education programs, engineering projects and enforcement to benefit pedestrians and bicyclists in Florida.
Doped $\alpha$-hematite with Molybdenum Sulfides MoS$_2$ for photoelectrochemical applications

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Keywords: Water Splitting, Photoelectrochemical, Hematite ($\alpha$-Fe$_2$O$_3$).

The photoelectrochemical (PEC) device greatly appeals to researchers due to its characteristics to split water in hydrogen and oxygen [1]. The alpha ($\alpha$)- hematite (Fe$_2$O$_3$) based PEC device is attractive due to splitting of water, and its physical properties such as bandgap besides its chemical robustness and availability in the nature. The electronic properties of $\alpha$-Fe$_2$O$_3$ is generally controlled through doping with non-metal and metal ions [2-5]. However, the $\alpha$-Fe$_2$O$_3$ suffers from low conductivity, slow surface kinetic, low carrier diffusion, and greater electron-hole combination. We understand that the carrier mobility and diffusion of $\alpha$-Fe$_2$O$_3$ can be improved by doping with dichalcogenide such as molybdenum disulfide metal (MoS$_2$) ions.

So, we have doped MoS$_2$ ions in different ratio of $\alpha$-Fe$_2$O$_3$ using sol-gel technique. The $\alpha$-Fe$_2$O$_3$, MoS$_2$ doped $\alpha$-Fe$_2$O$_3$ nanomaterials were characterized by using SEM, X-ray diffraction, optical techniques, respectively. The electrochemical technique was used to understand the $\alpha$-Fe$_2$O$_3$, MoS2 doped $\alpha$-Fe$_2$O$_3$ electrolyte interface properties. The synthesized MoS$_2$ doped $\alpha$-Fe$_2$O$_3$ nanomaterials have shown the dense structure with enhanced optical properties. The metal doped $\alpha$-Fe$_2$O$_3$ shows the rhombohedra structure. The metal ions doping has been observed using FTIR and Raman studies. The photocurrent obtained in MoS$_2$ doped $\alpha$-Fe$_2$O$_3$ based nanostructured films have shown improved production of hydrogen. The mechanism of the water splitting using MoS$_2$ doped $\alpha$-Fe$_2$O$_3$ nanomaterials is shown in the manuscript.

References:
Impact of Noise from the Acela Express on Residential Property Prices

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\textbf{Keywords:} High-Speed Rail, Noise, Residential Property Prices, Hedonic Regression

The High-Speed Intercity Passenger Rail Program (HSIPR) currently has over 40 applications requesting more than $75 billion towards investment in rail infrastructure, which indicates that the demand for high-speed corridors in the United States is increasing. However, in order to accommodate the expansion of this mode of transportation, current regulations relating to high-speed rail will need to be created and amended in order to ensure that safety and emission standards are met. One such regulation will be that of noise emission standards for interstate rail carriers since the current noise emission limits set by the Federal Railroad Administration (FRA) are based on speeds less than 150 mph. The unique noise characteristics of high-speed rail (HSR) due to increased operational speeds (between 160-220 mph), innovative designs, and operation will cause the noise thresholds to differ from those of conventional trains, thereby disrupting the current noise levels of households located near potential high-speed track.

This poster presents a study of the economic impact of noise from the Acela Express on residential properties along the section of track where the Acela reaches its maximum operational speed of 150 mph. The Acela Express, operated by Amtrak and traversing in the Northeast Corridor (NEC) of the country, is the only HSR currently operating in the United States (based on speed and distance traveled). The objective of this research is to test whether there was a significant differential in property sale prices of residential units in close proximity to the rail tracks when compared to the period before the announcement and opening of the Acela Express. Using a quasi-experimental design, estimates of noise from the operational speed of the Acela Express are estimated using the guidelines set by the FRA and a hedonic price regression relating the sale price of residential units to housing, spatial, and noise characteristics is employed. The results of the hedonic price regression are presented and the relevant estimates are explained.
Effects of Alkalinity and Biosolids on Methane Yield and Hydrogen Sulfide (H2S) Corrosion in High-Solids Anaerobic co-Digestion

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Keywords: High-Solids Anaerobic Co-digestion, Biogas, Methane, Hydrogen Sulfide

Biodigesters are a renewable energy technology as the biogas that it produces can be used as an energy source. Biodigesters decompose organic residues in an oxygen free environment through a process called high-solids anaerobic co-digestion (HS-AcD). It converts vegetation, food, and animal waste into biogas as well as non-hazardous compost for land applications. Biogas is mainly composed of methane (CH₄) and carbon dioxide (CO₂), with traces of hydrogen sulfide (H₂S). Since methane can be combusted or oxidized, it can be used in gas stoves or in gas engines to convert the energy into heat and electricity. Methanogens, microorganisms that produce methane through methanogenesis, are highly affected by pH. Ranges of pH from 6.5 to 8.0 have been found to be ideal for the production of methane. Since the acidity of biodigesters increases over time, lime and oyster shells can be used as a source of alkalinity to buffer the pH from changing, thus prolonging the production of methane. Also, the addition of biosolids, dead wastewater treatment plant microorganisms, is said to aid in the rate of methanogenesis.

For this experiment, small-scale biochemical methane potential reactors (BMPs) were used as the sampling method. The BMPs contained seven different mixtures of food waste, yard waste, lime or oyster shells, inoculum (sludge), and biosolids. From the experiment it was concluded that oyster shells were as good as lime at maintaining a healthy pH. No significant changes were seen in methane yield for the different alkalinity sources. Oyster shells are preferable as an alkalinity source because they are a byproduct of the fishing industry and are more available in Florida. Biosolids addition aided in the methane yield in HS-AcD, but also increased the H₂S concentration in the biogas. Removal of H₂S using common methods like activated carbon, silica gel, and zeolite would need to be incorporated since high levels of this gas cause corrosion, low energy efficiency, and decreased life of thermal engines.
Speed Harmonization Algorithm using Connected Autonomous Vehicles

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Keywords: Connected and Automated Vehicles, Vehicle Trajectory, Harmonization Algorithm

Freeway bottlenecks often cause traffic capacity drops and speed oscillations that not only compromise traffic performance at the bottlenecks but also likely propagate far backward to break down the upstream traffic. The adverse impacts of bottlenecks include more travel delay, excessive fuel consumption and emissions, and extra safety risks. With the advent of connected and automated vehicles (CAV) technologies, we can control detailed vehicle trajectory shapes within sensing, communication, computation, and physical limits. In this study, a CAV-based trajectory-smoothing concept is proposed to harmonize traffic and improve mobility and environmental impacts. The presented algorithm is applicable to mixed-traffic environments where only a portion of vehicles are CAVs. Simulation analyses are performed to assess the algorithm performance. The results show significant improvement in traffic throughput as well as in fuel consumption and emissions.
Light Olefin Production by Cracking of \textit{Nannochloris Oculata} microalgae using Aluminosilicate Catalysts

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Keywords: Microalgae, Light Olefins, Catalyst, Cracking, Sustainability

Olefins are the backbone of the chemical industry because they serve as the chemical building blocks for the manufacture of polymers, fibers, and numerous organic chemicals. Feedstocks such as naphtha, natural gas and liquefied petroleum gas (LPG) are currently used for the production of light olefins, but they are non-renewable and hence unsustainable. In contrast, biomass as a potential feedstock for the production of fuels and chemicals is renewable. Microalgae, in particular, are a promising resource due to their fast growth rate and ability to act as a CO\textsubscript{2} sink. In this study, we investigate the production of the light olefins ethene, propene, and butene from the marine microalga \textit{Nannochloris oculata} using aluminosilicate catalysts by studying the effect of catalyst to cell mass ratio on the production of these chemicals.

Wet \textit{Nannochloris oculata} paste with 80\% moisture was dried in an oven overnight at 60\textdegree C. The cell mass consisted of 50.7 wt.\% protein, 1.4 wt.\% crude fiber, 21.5 wt.\% ash, and 10.6 wt.\% crude fat on a dry basis. Thermal cracking was conducted using aluminosilicate catalysts in a semibatch reactor system and gas analysis was performed using mass spectrometry.

Cracking of \textit{Nannochloris oculata} in the absence and presence of aluminosilicate catalysts was conducted at varying catalyst to algae ratios at temperatures up to at 800\textdegree C. The light olefins ethene, propene, and butene were obtained as a major product. Although ethene was the most significant product, the concentration of all olefins increased significantly in the presence of the catalyst.
Direct Numerical Simulation and Measurements of Scalar Transfer Across an Air-water Interface during Inception and Growth of Langmuir Circulation

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Keywords: Direct Numerical Simulations, Freely Deforming Interface, Langmuir Turbulence

Direct numerical simulations (DNS) of an initially quiescent coupled air-water interface driven by an air flow with free stream speed of 5 m/s have been conducted and scalar transfer from the air side to the water side and subsequent vertical transport in the water column have been analyzed. Two simulations are compared: one with a freely deforming interface (giving rise to gravity-capillary waves and aqueous Langmuir turbulence (LT) characterized by small-scale (centimeter-scale) Langmuir cells (LC)) and the other with the interface intentionally held flat (i.e. without LC). It is concluded that LT serves to enhance vertical transport of the scalar in the water side and in the process increases scalar transfer efficiency from the air side to the water side relative to the shear-dominated turbulence in the flat interface case. Furthermore, transition to LT was observed to be accompanied by a spike in scalar flux characterized by an order of magnitude increase. These episodic flux increases, if linked to gusts and overall unsteadiness in the wind field, are expected to be an important contributor in determining the long-term average of the air-sea gas fluxes.
**TouchChromic device based on nanocomposite polymer-dye film**

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**Keywords:** TouchChromic Device, Composite Polymer-Dye Thin Film

Recently, we have reported novel and cost effective thin film based nanocomposite layer which enables cutting edge reversible color change from dark to transparent in the thin film when touched by a specific metal without any further external excitation, specifically voltage, light and temperature [1, 2]. The building structure of touchchromic device is based on coated with nanocomposite layer on conducting surface; a solid, liquid or gel electrolyte on the translucent conductive substrate and a metal touch for color change. The coloration and discoloration basically depends upon various attributes like composition of the electrolyte, film thickness and nature of composite film.

Under this work, we have developed the polymer composite -dye thin film on a conducting substrate using electrochemical technique. The composite film was characterized using UV-vis, FTIR, SEM techniques. The coloration and decoloration of composite film was studied with two different metals (iron and nickel). The coloration and decoloration depends on the properties of metal and type of electrolyte. The TouchChromic device can find applications in windows and displays.


Expediting the Consolidation of Clayey Soils based on Radio Wave Heating

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Keywords: Consolidation of Clayey Soils, Radio Waves

In this poster a study aiming to expedite the consolidation of clayey soil using radio waves is presented. Pre-consolidation is used as a method of overcoming long term settlement problems encountered when constructing on clayey soils. It is evident that the rate of settlement is significantly increased by an increase in temperature of the soil. In recent years, interest has shifted towards utilizing electromagnetic waves (radio waves in particular) to increase the temperature of the soil. Operating on principles of radiation, radio waves could be utilized to heat soil effectively to high temperatures.

In this poster, the effect of temperature on consolidation, the principles of radio wave penetration in soil and the subsequent heat generation is explained. A model experiment of a clay heating system based on radio waves is to be conducted. Additionally, the heat propagation and the subsequent drainage of pore water is to be theoretically analyzed. Finally, the rate of consolidation using radio waves with that of conventional methods is to be compared.
Evaluation of Wastewater Disinfection with Hypochlorite

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Keywords: wastewater, hypochlorite disinfection, disinfection by products, DPBs, trihalomethane, THM, chlorine, PH, TOC, treatment

Disinfection is an essential process in the treatment of municipal wastewater before the treated wastewater can be discharged to the environment. Hillsborough County’s Northwest Regional Water Reclamation Facility (NWRWRF) in Tampa, Florida, currently uses ultraviolet (UV) light for disinfection. However, this method has proven expensive to implement and maintain, and may not be effective if the light transmission is poor. For these reasons, Hillsborough County is considering switching from UV light to sodium hypochlorite for disinfection. However, hypochlorite (chlorine) disinfection has disadvantages as well, such as the production of disinfection by-products (DBPs) such as trihalomethanes (THM) and haloacetic acids (HAAs), which may have adverse impacts on the quality of surface waters that receive the treated wastewater.

The quality of final effluent was monitored at NWRWRF and at two nearby wastewater treatment plants that currently use hypochlorite for disinfection. At these two facilities, pH of 7.0–8.0, chemical oxygen demand (COD) of 12–26 mg/L, alkalinity of 200–250 mg/L as CaCO₃, chlorine residual of 1.5–6.0 mg/L, and total trihalomethanes of 100–190 μg/L (mostly chloroform) were observed.

As expected, free chlorine residual decreased with an increase in temperature from 23°C to 30°C. Surprisingly, residual at 16°C was observed lower than residual at 23°C. The production of THMs increased with higher contact time in all the experiments completed. Chlorine dose didn’t have an effect on THM formation at 23°C, but it did at 30°C and 16°C, where THM concentrations were generally higher with the increase of chlorine dose. Temperature effect was noticed in most of the experiments, where THM production was usually higher at higher temperatures, except some cases where formation was similar for different temperatures. Chloroform, dichlorobromomethane, dibromochloromethane production ranges were respectively: 20-127 μg/L, 18-59 μg/L, and 3-7 μg/L. Bromoform were not observed in this experiment at any temperature or chlorine dose.

Experimental results on NWRWRF filtered effluent showed that only dichlorobromomethane exceeded the limits set by FDEP at about 30 min contact time for all temperatures and chlorine doses tested. However, according to Florida Administrative code 62-302-400, proposed changes to the code have set higher DCBM limit of 57 μg/L. Chlorination would be recommended at NWRWRF if the DCBM regulated limit increases to 57 μg/L. At 16 and 23°C, a chlorine dose of 9 mg/L and at 30°C, a chlorine dose of 12 mg/L is recommended for NWRWRF.
Material discovery for sustainable CO\textsubscript{2} conversion in thermochemical cycles

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Keywords: Carbon Dioxide Conversion, Perovskite Oxides, Thermochemical Cycles

Achieving a sustainable route for hydrocarbon fuel generation from carbon dioxide has garnered a lot of attention in recent times. Solar thermochemical route\textsuperscript{1,2,3} has shown great potential for CO\textsubscript{2} conversion and perovskite oxides have posed themselves as ideal candidates for this purpose. In this process, perovskite oxides of the form (ABO\textsubscript{3}) is first reduced to ABO\textsubscript{3-δ} at high temperatures, while in the second step, the materials are oxidized back to their stoichiometric forms while the CO\textsubscript{2} is converted to CO. This CO can then be further hydrogenated to hydrocarbon fuels. A modified approach of this process is the use of renewable hydrogen during the reduction of the perovskite oxides. This process is named as reverse water gas chemical looping (RWGS-CL) and has the ability to create oxygen vacancies at much lower temperatures (~500 °C). The success of these CO\textsubscript{2} conversion processes lies greatly on the perovskite oxide’s oxygen vacancy formation capacities. The oxygen vacancy formation characteristic is greatly dominated by the materials composition. Perovskite oxides have the ability to accommodate one or more elements on the ‘A’ and ‘B’ sites, thereby forming structures like A\textsubscript{1(1-x)}A\textsubscript{2}BO\textsubscript{3}, AB\textsubscript{1(1-y)}B\textsubscript{2}O\textsubscript{3}, and A\textsubscript{1(1-x)}A\textsubscript{2}B\textsubscript{1(1-y)}B\textsubscript{2}O\textsubscript{3} along with ABO\textsubscript{3}. Hence, a screening study was undertaken for the prediction of appropriate materials for this purpose. Four different elements - lanthanum, strontium, barium and calcium were chosen for the ‘A’ site while the 3d transition metals along with aluminum and gallium were used for the ‘B’ sites. Density Functional Theory (DFT) calculated oxygen vacancy formation energies were used as a descriptor to screen the materials. The relation of these oxygen vacancy formation energies with respect to the intrinsic material properties has been empirically modeled as well. The CO\textsubscript{2} conversion abilities of the predicted materials were validated through experiments.

References:

Stochastic investigation of the feasibility of using remotely sensed moisture data for rainfall induced landslide hazard assessment

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Keywords: Remote Moisture Data, Landslide Hazard Assessment

The ability for timely evaluation of sudden increases in ground moisture levels would be a valuable tool in reliable landslide risk assessment due to rainfall triggered landslides. Surface soil moisture estimated based on satellite images would be vital in such evaluations. In this study, three alternative stochastic classification models, logistic regression model, decision tree and bagging have been developed to identify locations of high landslide risk based on site attributes of geology, soil type, slope, land cover and the corresponding satellite based soil moisture estimates. As opposed to the commonly used validation set approach, in this work, cross validation was employed to improve the prediction accuracy of the models. It was seen that all three classification models provided reasonably accurate predictions. It is expected that the findings of this research would lay the ground work for the future formulation of a timely, reliable and effective method for landslide hazard prediction.
Microbial Fuel Cells for Nutrient Removal from Wastewater

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

Wastewater treatment plants remove a number of contaminants prior to discharging treated effluent. Removing nitrogen from wastewater prevents algae blooms but usually requires expensive chemical and energy input. To address this problem, nutrient-rich digestate in the sidestream can utilize microbial fuel cells to remove ammonium and recover energy, thereby saving wastewater treatment plant significant costs in chemicals and energy. The overall objective of this project will be accomplished through achieving the following specific goals:

1. Build a microbial fuel cell that treats digester effluent, and quantify nitrogen removal and net energy output. The working hypothesis is that a microbial fuel cell can remove 90% of the nitrogen entering the microbial fuel cell and can simultaneously provide positive net energy output.

2. Install the microbial fuel cell downstream of a struvite precipitation reactor and quantify the combined nitrogen and phosphorus removal/ recovery and energy output. The working hypothesis is that by combining these two technologies in series, we will be able to achieve an overall recovery of at least 80% of the phosphorus and an overall removal of at least 90% of the nitrogen while providing a net production of energy.
A 2D Drinking Water Distribution Network Model for Hydraulics and Water Quality

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Keywords: Drinking Water, Computational Fluid Dynamics, Water Distribution Network, Disinfectant Residual, Hydraulic Model.

Predicting the water hydraulics and the water quality in a drinking water distribution systems is essential for drinking water utilities and public health in general. This allows for a control of the distribution system, better resource allocation and most importantly, it ensures high drinking water quality is delivered to the consumer at all time. Modelling, in particular using 2D network models (e.g. EPANET), has allowed water utilities to gain insight into their pressurized pipe systems. With growing stress on water resources and the long-term impact of climate change, drinking water sources are becoming diverse within a single distribution network generating demand for improved 2D network models.

In this study, a 2D network model of the Tampa Bay Water regional distribution system has been developed and predictions of pressures throughout the network are in good agreement with physical measurements. Presently we are incorporating a water quality component into the model in order to predict disinfectant residual throughout the network. The resulting framework will be put to use to analyze a recently discovered transient water quality deficiency in the Tampa Bay Water regional distribution system in the form of sudden drops in disinfectant residual at certain locations of the network. It is hypothesized that these drops are related to the fact that the distribution system blends water from multiple sources (groundwater, surface water, and seawater) treated with different processes and chemicals throughout a complex regional network. This hypothesis will be explained further in the presentation.
Energy Storage Mechanism in Perovskite Solar Capacitors

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Keywords: Solar Capacitors, Perovskite Materials, Polyaniline

The rise of organometal halide perovskite materials as sensitizers in preference to synthetic dyes has evolved solar energy technology. Perovskite solar cells have been reported to surpass 20% efficiency therefore potential candidates to substitute silicon based solar cells offering lower cost. The introduction of a capacitive mechanism in a device based on perovskite materials enables the device to harvest energy and store it concurrently. The basic configuration of the resulting single two terminal device is similar to a dye sensitized solar cell. The working compartment, however, consists of highly photoactive perovskite material and a conducting polymer (e.g. polyaniline) with low absorption coefficient and excellent electrochemical stability. The counter compartment consists of extensively porous carbon materials with high electrical conductivity. High energy absorption coefficient of perovskite material across visible spectrum and low voltage requirement for initiation of charge storage are the keys to prosperity of this hybrid device. In this work, the photoelectrochemical reactions in composites of polyaniline (PANI) and their charge storage mechanism have been studied. The cyclic voltammetry (CV) results showed the amplitude of the redox peaks changes significantly upon illumination. The amount of stored charges in the polymer was estimated from the CV results. The results encourage the application of PANI for charge storage in the perovskite based hybrid devices.
Environmental analysis of organic waste treatment focusing on composting scenarios

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Keywords: Composting, Organic Waste, Home Composting, LCI, LCA

The correct disposal of the waste generated by human activities is one of the prevalent challenges that the world faces towards a sustainable development. The lack of suitable sites and the high cost of waste treatment have persuaded many municipalities to implement a policy for integrated waste management, which includes measures such as, source reduction, reuse, recycling, composting and final disposal in landfill. This study examined the alternatives for composting of the organic waste generated in the city of Bauru, in the state of São Paulo, which does not have a composting plant, and analyzed the environmental impacts of seven scenarios: current situation, in which all organic waste is disposed at the landfill; dispatch of the organic waste generated in the city to the closest municipality having a composting plant; construction of a composting plant in Bauru; use of home composting for 10%, 25%, 60% and 90% of organic waste.

The method consisted of literature review, data collection among the company responsible for the waste management in the municipality, and the Life Cycle Assessment of the scenarios through the software IWM-2 for the Life Cycle Inventory and Recipe2008 conversion factors for the following impact categories: climate change, ozone depletion, particulate matter formation, and human and freshwater toxicity. The results showed that home composting must be followed by a reduction in the organic waste collection days, in order to have a positive effect in the greenhouse emissions derived from transportation and collection. Also home composting has a greater potential to reduce carbon dioxide equivalent emissions per mass of waste composted in comparison with composting plants. The use of transfer station can have a positive effect on composting plants that are located in other municipalities.

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Keywords: Single Motorcycle Crash, Injury Severity, Horizontal Curve, Random Parameters, Unobserved Heterogeneity, Mixed-Effects Logistic Model

Horizontal curves have been of great interest to transportation researchers because of their expected safety hazards to motorcyclists. The impacts of horizontal curve parameters on motorcycle crash injuries were not well quantified in past studies. This paper aims to investigate and quantify the effects of horizontal curve parameters and associated factors on the injury severity of single-motorcycle crashes considering the issue of unobserved heterogeneity.

A mixed-effects logistic model was developed based on 2,168 single-motorcycle crashes, which were collected on 8,597 horizontal curves in Florida for a period of 11 years (2005–2015). Four normally-distributed random parameters (moderate curves, S-curves, older riders, and male riders) were identified to address random effects on the motorcycle injury severity. The modeling results showed that sharp curves (radius < 1500 ft), compared to flat curves (radius ≥ 4000 ft), tend to increase significantly the probability of severe injury (fatal or incapacitating injury) by 7.7%. The effects of moderate curves (1500 ft ≤ radius < 4000 ft) are insignificant on average but random (46.3% decreasing vs. 53.7% increasing). Overall, S-curves are more likely to increase the probability of severe injury by 5.82%. Rider risk-adjusting behaviors (psychologically feeling confident, then riding dangerously, or vice versa) may result in counterintuitive effects (e.g., vegetation and paved medians, full-access-controlled roads, pavement conditions), or random effects (e.g., moderate curves, S-curves). Other significant factors include lighting conditions (darkness, darkness with lights), weekends, speed/speeding, collision type, alcohol/drug impairment, and helmet use.
A Novel Algal-Bacterial Shortcut Nitrogen Removal Process for High Ammonia Strength Wastewater Treatment

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Keywords: Algal-bacterial Consortium, High Ammonia Strength Wastewater, Shortcut Nitrogen Removal, Photobioreactor

The discharge of nutrient-rich wastewater from municipal wastewater treatment plants to the environment causes eutrophication of aquatic ecosystems and their degradation. One way of preventing eutrophication is the treatment of high ammonia strength reject water, which is a liquid fraction from sludge dewatering. Since the conventional nitrification/denitrification with mechanical aeration is an energy intensive process, alternative treatment methods such as shortcut nitrogen removal through nitrite (NO$_2^-$) (nitritation/denitritation) have gained increased attention. Shortcut nitrogen removal offers a number of advantages: reduced aeration (decrease in energy demand), alkalinity and carbon source requirements.

A novel algal-bacterial shortcut nitrogen removal process can further reduce costs, chemical and energy requirements and improve removal efficiency. Oxygen for aerobic microbial activity in such systems is supplied by algae through photosynthesis which reduces aeration demand. Nitrogen removal in an algal-bacterial photobioreactor is closely related to oxygen production, which depends on both the intensity of light and its availability for algae inside the reactor affected by the density of biomass governed by solids retention time (SRT). Our prior research showed the effective removal of ammonium from anaerobically digested swine manure centrate via nitritation/denitritation using an algal-bacterial sequencing batch photo-reactor operating at an SRT of 8 days with alternating light and dark periods. More research is needed to understand these dominant factors and select the optimum conditions that will sustain this novel process. Therefore, the objectives of this study are to investigate 1) the effect of different SRTs and 2) illumination on system’s kinetics and performance.
Research Category # 2: Materials Science, MEMS/NEMS, Nanotechnology, Biomedical, and Health
Novel Molybdenum Disulphide–Conducting Polymer Nanocomposite Electrode Material for Supercapacitor Applications

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Keywords: Supercapacitors, Nanocomposite Electrode Material

Electrochemical supercapacitors become the new revolution in the field of energy storage. Our group has done extensive work on supercapacitor based on nanocomposite (polyaniline-graphene (G), polypyrrole (PPY)-graphene, MWCNT-PPY, RuO₂-graphene, MnO₂–G, polyethylenedioxythiophene (PEDOT)–G etc.) based electrode materials [1-3]. Recently, composites based on conducting polymers and two-dimensional (2D) layer structure transition metal oxides (2D) molybdenum disulphide (MoS₂) has been shown to be a promising electrode material for supercapacitor applications.

We have studied supercapacitor on MoS₂-PEDOT nanocomposite electrode material. The MoS₂-PEDOT nanocomposite was synthesized in aqueous based system under controlled condition. We have used morphology and crystalline structure characterization methods such as Scanning Electron Microscopy (SEM), Raman spectroscopy, X-ray-diffraction, and Transmission Electron Microscopy (TEM) techniques. Cyclic Voltammetry, Chronoamperometry, Electrochemical Impedance, Charging –Discharging etc., electrochemical measurements were performed to understand the specific capacitance, power and energy of supercapacitor. The supercapacitor fabricated from MoS₂-PEDOT based electrode has shown high energy density compared to graphene based nanocomposite electrodes. This study provides a fundamental understanding for high performance supercapacitor based on MoS₂-PEDOT based nanocomposite electrode material.

References
Design and Fabrication of Metal-Insulator-Metal Diode using Langmuir-Blodgett technique for IR Detection and Energy Harvesting

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**Key words:** Metal-Insulator-Metal Diode, Langmuir-Blodgett, ultra-thin film, Photo-lithography

Among the various applications of antenna coupled MIM diode (Rectenna), IR detector and energy harvester have drawn immense attention for their use in military and commercial interests. A rectenna is basically an antenna which captures electromagnetic radiation and a rectifier (diode) that converts AC antenna output to DC signal. Quantum based tunneling mechanism helps MIM diodes to rectify at high frequency signals.

The efficiency of rectenna mostly depends on diode performance. The diode performance, on the other hand, largely depends on ultra-thin insulating layer which is sandwiched between two metallic electrodes. A highly structured pinhole free ultra-thin uniform insulating layer is the requirement for a diode to have the optimum performance. The Langmuir-Blodgett (LB) deposition method has advantages over other deposition techniques to fabricate ultra-thin insulating layer required for MIM diode.

In an effort to produce a MIM tunnel diode, thin nanolayer film of ZnO was synthesized from organic precursor LB film which could be used as insulating layer in MIM diode. The LB monolayers of zinc stearate were deposited on silicon, glass, FTO and Gold (Au) plated Si substrates. The zinc stearate multilayers LB films were annealed at two different temperatures (300 °C and 550 °C) to synthesize thin layer of zinc oxide (ZnO) film. The zinc stearate and ZnO films were characterized by XRD, AFM, FTIR, EDS and cyclic voltammetry (CV) techniques. X-ray diffraction measurement has shown hexagonal wurtzite structure of the ZnO. The average surface roughness was estimated to be 1.076 nm using atomic force microscopy (AFM). Moreover, the metal-insulator-metal (MIM) diode structure was realized by sandwiching ZnO thin film layer prepared from LB precursor between thin layer of Au/Cr and Ni substrates. The top and bottom electrodes as well as active area of the diodes were patterned using UV-photolithography technique. The electron tunneling conduction mechanism has been understood through the current-voltage (I-V) characteristics of the MIM diode. The highest measured sensitivity $\sim$37 (A/W) and the rectification ratio $\sim$15 at $\pm$100 mV of the fabricated MIM diode has indicated its potential application in infrared sensing.
Silicon Carbide as a Robust Neural Interface

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Keywords: Silicon Carbide, Intracortical neural interfaces, Brain Machine Interface

Intracortical neural interface (INI) could be a key component of brain machine interfaces; devices which offer the possibility of restored physiological neurological functionality for patients suffering from severe trauma to their nervous system. Unfortunately, the main components of the INI, microelectrodes, have not shown appropriate long-term reliability due to multiple biological, material, and mechanical issues. Silicon carbide (SiC) is a semiconductor that is chemically inert within the physiological environment and can be micromachined using the same methods as with Si microdevices. We are proposing that a SiC material system may provide the improved longevity and reliability for INI devices. The design, fabrication, and preliminary electrical and electrochemical testing of an all-SiC prototype microelectrode array based on 4H-SiC, with an amorphous silicon carbide (a-SiC) insulator, is described. The fabrication of the planar microelectrode was performed utilizing a series of conventional micromachining steps. Preliminary electrochemical data are presented which show that these prototype electrodes display suitable performance.
Analysis of Posture Improvement in Pianists Using Fit to Play Course

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Keywords: Physical Therapy, Yoga, Posture Improvement

Concert pianists seek to obtain a back posture that is as close to perpendicular to the bench upon which they are seated. This study was carried out in an attempt to quantify and analyze how much a pianist’s posture can potentially improve through taking a semester of a college level music course called Fit to Play. The Fit to Play course offers physical therapy and yoga in conjunction with musical training in order to facilitate prevention of repetitive stress injury. The hypothesis of this study was that the posture of a concert style pianist would significantly improve through the attendance of the Fit to Play course. The data set for the subject of this study was collected in two separate sets, which both used a conjunction of eight infrared cameras, video camera, VICON motion capture system and Matlab in order to compute and record the biomechanical joint movements of the participant in order to calculate joint angles. The first set was taken at the beginning of the semester prior to the subject’s participation in the Fit to Play music course.

The second set of data was taken at the end of the semester after the subject’s completion of the Fit to Play course. During the semester the subject saw a physical therapist and performed yoga techniques in order to improve their posture and body motion control. The subject was outfitted with 33 motion tracking markers placed strategically to calculate the joint angles of subjects’ torso and asked to perform the musical score known as Liszt-Widmung, 1st theme, this procedure was repeated at the end of the semester to obtain the second set of data. After both the before and the after sets of data had been processed, the data set for the torso markers were studied and compared. This examination revealed that for the subject in question, the posture of their torso noticeably improved over the course of the semester. Specifically, the subject of the study significantly reduced the amount of tilting of their torso relative to the bench during the course of the song meaning that the Fit to Play course did succeed in improving performance posture of the concert pianists.
SiO$_2$-TiO$_2$ Composite Aerogel for Thermal and Reflective Applications

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**Keywords:** Aerogels, Paint Applications

Aerogels are porous materials produced via sol-gel and supercritical drying processes. Aerogels are translucent or transparent to visible light as well as possess low thermal conductivity and complex microstructure. Most of the aerogels have a low density (0.05 g/cm$^3$), very high surface area (1000 m$^2$/g) and high pore volume (18 cm$^3$/g) [1]. Recently, aerogel (SiO$_2$, TiO$_2$, Al$_2$O$_3$ etc.) material has been used for thermal insulation, reflection and self-cleaning applications.

We have developed composite aerogel for its use as a paint composition material. Initially, the xerogel was produced by mixing SiO$_2$ and TiO$_2$ sol to produce a mesoporous structure using sol-gel technique. The xerogel was then soaked in alcohol, acetone and hexane separately before drying using supercritical CO$_2$ drying process for obtaining the composite aerogel SiO$_2$-TiO$_2$ material. The composite SiO$_2$-TiO$_2$ aerogel was characterized by using SEM, X-ray diffraction and optical techniques. The thermal insulation of adhesive mixture can be increased by addition of composite SiO$_2$-TiO$_2$ aerogels.

An attempt is made to prepare the paint composition using different ratios of adhesive mixture with composite SiO$_2$-TiO$_2$ aerogel. The thermal insulation and heat reflection properties of coated aerogel composite paint were studied. The synthesized aerogel paint mixture has shown the dense structure with enhanced optical and thermal properties.

**References:**


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Keywords: Metal Organic Frameworks, 2D thin films, 3D thin films, Crystal engineering, Density of States, Photoemission Spectroscopy, Surface Science, Supramolecular electronics.

A gold surface pre-functionalized with 4-mercaptopyridine was used to control the growth and facilitate charge transfer of epitaxial layers of MOF 2-dimentional nano thin films from the self-assembly of porphyrin based organic conductive ligand, and self-organization of suitable copper-based paddlewheel secondary building units (SBUs) with the amalgamation of organic bridging ligands to construct 3D MOF nano thin films.

MOF multilayer thin films were deposited from solutions on the pre-functionalized surface in a glove box connected to an ultra-high vacuum system outfitted with photoelectron spectroscopy (PS). Their advanced physical electronics properties by photoemission spectroscopy (PS) were investigated by X-ray photoemission spectroscopy (XPS), ultraviolet photoelectron spectroscopy (UPS), and inverse photoemission spectroscopy (IPES). These results provide a unique insight into the full electronic states, the Highest Occupied Molecular Orbitals and Lowest Unoccupied Molecular Orbitals (HOMO and LUMO levels respectively), band gaps, and work functions of MOF based 2D and 3D thin films, thus setting paradigms for their implementation in bottom-up and self-assembled nano electronic devices.
Qualification of Printed Electronic Systems

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Keywords: Integrated Electronics

New printing technology allows the printing of integrated electronics into a structure with multiple materials. This technology brings about the need for qualification of these new components. Some of these test methods include die shear testing, hermetic testing, shock and vibration testing, and thermal cycling.
Wearable Technologies for In-home Sleep Studies: Hardware, Algorithms, Software and Validation

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Keywords: Sleep Study, Polysomnography, Biosensor

As of today, one of the biggest barriers in diagnosing or treating patients with sleep disorders has been the difficulty (and in most cases inability) to obtain continuous and objective assessments of a patient’s sleep in their natural settings. The goal of this project is the design, deployment and validation of hardware, algorithmic and software technologies to enable the feasibility of conducting in-home sleep studies that are accurate, automated, affordable and non-invasive.

In this poster, a wireless in-home sleep study device is presented. Using epidermal sensors placed on an elastomer backing layer, various biophysiological parameters can be measured. This includes EEG, EOG, EMG, skin temperature and galvanic skin response. With an additional clip placed on the nostril, blood oxygen saturation, heart rate and respiratory flow can be measured using a transmissive pulse oximeter transducer and a thermocouple.
Organic Vapor Sensing using Quartz Crystal Microbalance

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Keywords: Quartz crystal balance, acoustic, sorption, polymer, isothermal, biodegradable

Quartz crystal microbalance is the acoustic wave sensor used for gas and vapor sensing. The study discusses the isothermal solubilities of the homopolymers Polycaprolactone (PCL), Polyethylene glycol (PEG), and their copolymer (PEG/PCL) in four solvents: Benzene, Dichloroethane, Chloroform and Dichloromethane. The experiments were conducted and reported at 298.15 K. In this poster, the proof for a working model of the Quartz crystal microbalance apparatus was reported through a test-case. The test case consists of a study that details the solubility of the Polyisobutylene (PIB) polymer in benzene which was then compared to previous work published in the Journal of Chemical Engineering data book, 2002. The reproducibility of the data for the PEG, PCL, and PEG/PCL copolymer was also used to confirm the proper functionality of the equipment. The working apparatus consisted of a computer loaded with Labview software for data selection, a quartz crystal cell, four bubblers for solvents, a phase lock oscillator, a frequency counter, and a temperature controlled vapor dilution system.

The caprolactone in the PCL polymer is the leading biodegradable compound approved by the Federal Drug Administration (FDA) for drug delivery systems, implants, adhesion barrier and tissue engineering. The PEG/PCL copolymer will help attain the biomedical applications of caprolactones and other daily life uses of polymers. Given the wide range of applications, the study of these polymer-solvent interactions is of great interest to both academic and industry research as very little polymer property data exists in literature to date. Understanding the highly non-ideal behavior of these polymers in organic solvents will help in synthesis of the polymer manufacturing process. Thus, it is important to understand the polymer/solvent interaction before testing it for further use.
Thermo mechanical characterization of electrospun polymer and polymer nanocomposites

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Keywords: Electrospinning, High Porous Membranes, Polycarbonate Polyurethane

Electrospinning is a rapidly evolving technique used to create nanofibers from polymer solution or melts. This process has the ability to produce high porous membranes keeping with excellent mechanical and thermal properties. The fibers and fiber mats formed from electrospinning polymers have been applied to many fields such as the medical fields as wound dressings, grafts and prostheses.

Our novel thermoplastic polycarbonate polyurethane has been found to have high performance characteristics which become enhanced with the addition of silver, silica and carbon black nanoparticles. Polycarbonate polyurethane (PCPU) has biocompatible capabilities which have been used in wound dressings and balloon catheters. The silica, silver and carbon black nanoparticles utilized within this have sizes ranging from 7nm to 100nm. Fillers are usually added to polyurethanes to convey enhanced mechanical, thermal and adhesion properties through the fillers ability to form a boundary layer matrix on its surface. Silver nanoparticles are known to have antimicrobial benefits which work hand in hand with the biocompatibility of PCPU. Nanosilica is in the form of a hydrophilic nanoparticle which has hydroxyl groups at its surface has been shown to improve toughness in polymers because of its high modulus as well as create a three dimensional network by hydrogen bond interaction between the silanol groups on the surface of the silica and the carbonyl groups within the polymer. Carbon black nanoparticles have been known to impart increased conductivity within polyurethanes which can be used in electronic applications. Even small variations in concentration of nanofillers can optimize mechanical, chemical and optical properties when there is a strong chemical interaction between the fillers and polymer matrix. Herein we utilized thermal and mechanical testing to characterize our electrospun thermoplastic polyurethane nanocomposite using FTIR, DSC, Surface Tension and X-ray diffraction.
Tribocorrosion in Taper Junction of Total Shoulder Arthroplasty: A Pilot Study

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Keywords: Total Shoulder Arthroplasty, Tape Junction, Tribocorrosion

Total shoulder arthroplasty is a highly successful surgery for management of a wide variety of shoulder problems such as arthritis, fractures and rotator cuff muscle tear. New developments in implant design as well as changing patient demographics have led to an increased utilization of this surgery. It has been estimated that in the last decade there was a five-fold increase in primary shoulder arthroplasty that subsequently let to a rapid (four-fold) increase in shoulder arthroplasty revisions. The total shoulder implant consists of two main parts: the stem, which is inserted into the proximal humeral shaft, and the head, which is attached to the stem via a mechanical junction. Taper junction is the most common method of component fixation in modular arthroplasty designs. It has been shown that tribocorrosion at the taper can have a negative effect on implant survivorship in hip arthroplasty. Adverse effects caused by metal debris and subsequent elevated serum metal ion levels are frequently reported in total hip arthroplasty. Its effect in the shoulder remains elusive as there are very limited numbers of studies with very small sample sizes published.

A total of 33 implants were collected and graded for tribocorrosion with a modified Goldberg score. The process consists of retrieving explants, clinical history, patient demographics and implant information for further analysis. Tribocorrosion was graded on a scale from 1 to 4 depending on the extent and magnitude of the damage. The taper interfaces were macroscopically evaluated three times and the average round up score was used in the analysis. Due to the small sample size in this pilot only non-parametric tests were utilized to compare continuous and categorical variables (Mann-Whitney U test, Spearmen rank correlation).

Tribocorrosion was present (grade >=2) in 31 stems (93%) and 29 humeral heads (87%). Fifteen male subjects and eighteen female subjects were evaluated. There was no statistical significance between genders and tribocorrosion score (stem: p=0.116, head: p=0.173). There were two manufactures (DJO surgical n = 27; Stryker n = 6). There was no statistical significance in tribocorrosion grade between the two companies (stem: p=942; head: p=655). On average, explants were retrieved at 5.6 months post-surgery (st.dev. 4.3 month). There were no statistically significant tendencies between total time in-vivo and tribocorrosion grade (stem: R=-0.091; head: R=-0.005).

Tribocorrosion takes place in modular junctions of Total Shoulder replacements. This pilot work showed that it is possible to evaluate the tribocorrosion in shoulder arthroplasty. In the future work we aim to include larger number of explants and evaluate more geometry, material, implant and patient related factors.
Recombinant Elastin Based Nanoparticles for Targeted Gene Therapy

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Keywords: Elastin-like Peptides, Gene Therapy

Gene therapy is a technique used to inactivate, replace, or insert a corrective copy of a defective gene in order to help diseased tissues to function properly. Gene therapy is a promising treatment for genetic diseases such as cystic fibrosis, cancer, and Parkinson’s. There are no cures for these diseases. Scientists have used multiple methods to introduce a gene to the cell. One of these methods is the use of viruses because they are an attractive option. Among viruses, lentiviruses are popular vectors for gene delivery due to their efficient mode of gene delivery. However, the non-specific delivery gene associated with viruses may result in undesirable side effects. We proposed a heterogeneous nanoparticle delivery system for targeted delivery of lentiviral particles containing a therapeutic gene. The heterogeneous nanoparticles (NPs) consist of the low density lipoprotein receptor 3 (LDLR3) and the keratinocyte growth factor (KGF), each fused to elastin-like-polypeptides (ELPs), LDLR3-ELP and KGF-ELP, respectively. Our preliminary results show that LDLR3-ELP treatment blocked viral transduction. However, the treatment consisting of LDLR3-ELP and KGF-ELP resulted in the increase of viral transduction. Overall, this novel design may perhaps help with the targeting of specific cells that overexpressed growth factor such as KGF receptor (KGFR).
Large Area Selective Sintering

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Keywords: 3D Printing, Additive Manufacturing, Projection, Temperature Control

A projection based sintering system was developed and characterized. This system and the resulting parts are presented on this poster. A projector was modified to allow it to create very high power images. These high power images were projected on a preheated bed of nylon powder, fusing the powder particles together in the shape of the projected image. The components were created with varying exposure times and intensity values. Tensile test specimens were created with this method and characterized by measuring the thickness and maximum force of each specimen. The specimens were also cross sectioned and viewed with a scanning electron microscope to measure the density. It was found that longer exposure times with low intensity values required more total energy input to receive similar results as short exposure times with high intensities. This was attributed to thermal loss from conduction and convection to the surrounding air and adjacent powder particles.
Perovskite based photosensor for electrochemical studies

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Keywords: Perovskite, Photoactive material, Photosensor, Electrochemical Device

Photosensors are used for the detection of analytes in microfluidic devices. In order to detect materials with low concentrations, a sensor with high sensitivity is required. Perovskite has been studied extensively as a photoactive material in solar cells due to its wide absorption spectrum and low recombination rate of charges which also make it a suitable candidate for photosensors. In this work, the photoconductivity of the material in a thin-film resistor is studied. The resistance of the device is measured at different wavelengths and intensities. A significant change of the resistance is observed upon illumination indicating the adequacy of the device to serve as a photosensor. However, in this case, the perovskite layer must be protected with an insulating thin film to avoid undesired reactions and contacts. The perovskite film was also tested as an electrochemical photosensor. The current-voltage characteristics of the device showed a diode rectifying response both in dark and under illumination. In this case, the photo response of the device established promising results for applications in photosensors with a relatively high stability in a liquid media.
Experimental and theoretical investigation of mechanical response of laser-sintered diamond lattice structures

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\textbf{Keywords:} Additive Manufacturing, Laser-Sintered Diamond Lattice Structures

Typically, additive manufacturing (AM) processes are limited to a single material per part while many products benefit from the integration of multiple materials with varied properties. To achieve the benefits of multiple materials, the geometric freedom of AM could be used to build internal structures that emulate a range of different material properties such as stiffness, Poisson’s ratio, and elastic limit using only one build material. This research examines the range of properties that can be simulated using diamond lattice structures manufactured from Nylon 12 with a commercial laser sintering process. Stiffness and energy absorption were measured for all parts and compared to finite element analysis (FEA). Simulation shows agreement with experimental results over a stiffness range of four orders of magnitude once a correction factor is applied. Experimental results also show a wide range of energy absorption for diamond lattice structures and a significant increase in the effective elastic limit of the material - compensating for the low ductility of many AM materials. Extrapolating this data into lattice structures made from metal, these same structures could mimic a wide range of “fully” dense and porous materials with just the use of a single material. Since the diamond lattice is a cellular structure, the voids can also be filled with other materials/structures to add secondary control of functions such as energy storage, and sensing.
GPU Supported Large Scale Simulation Models for Influenza Pandemic Outbreaks

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\textbf{Keywords:} Influenza Pandemic, Agent-Based Simulation, Graphical Processing Units

Influenza epidemics are a serious global concern that threatens to turn into a pandemic. Health care professional and disease control experts and other medical practitioners are constantly seeking better understanding of the pandemic impacts while exploring effective pharmaceutical and non-pharmaceutical interventions to contain pandemic spread. In this pursuit, researchers have adopted different models based on differential equations, Markov chain Monte Carlo simulation, agent-based (AB) simulation, etc. Among these, AB simulation models appear most versatile capable of considering large population sizes, demographic variations, individual schedules and travels, contact and infection processes, and disease natural history.

However, the AB simulation models incorporating large populations have computational limitations. Addressing this limitation requires fast and highly parallel computing facility with large and high-throughput memory, which is often not supported by current CPUs. Over the past few years, with massive computing power and high-speed memory, graphical processing units (GPUs) have become a part of many high-performance computing systems. Originally designed for graphics processing, the use of general purpose computing on GPUs (GPGPU) has been boosted in recent years with the development of software frameworks such as compute unified device architecture (CUDA) and open computing language (OpenCL).

We develop a GPU supported AB simulation model capable of simulating a country wide influenza pandemic outbreak in the U.S. We consider census data to locate 318 million people as well as the schools, workplaces, and community/social gathering places across the country. We also incorporate detailed travel patterns of the people to facilitate movement and tracking of virus spread. A preliminary version of the model is tested for a A(H7N9) pandemic outbreak.
A Study on Wet Human Skin Phantoms for Biomedical Radiometry

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Keywords: Biomedical Radiometry, Phantoms, Silicone Oil, Urethane, Electrical Permittivity, Loss Tangent, Viscosity, Radio Frequency

In this work an investigation of urethane based biological phantoms is presented that provides a guide to estimate the real and imaginary permittivities of mixtures which are meant to mimic human tissues. Wet skin was used as a benchmark against which the values of the phantom were measured. The increase in real permittivity is achieved by introducing 7-11µm graphite powder to urethane substrates while the imaginary permittivity is controlled using 1000 cps silicone oil. A frequency range from 300MHz to 3GHz was used to target the values of wet skin. The measured values were compared to database measurements through a sweep of the aforementioned frequencies (eg. 1.5 GHz, $\varepsilon' = 44.90$, $\delta = 0.29329$, $\varepsilon'' = 13.17$). The results of a study on graphite concentration, silicone oil concentration and substrate viscosity are presented. The investigators are drawing from the previous findings of C. Gabriel et. al, and also Garrett and Fear.
Investigations of CoO-ATO Coatings for Silicon Solar Cells

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**Keywords:** Solar Cell, Electrospinning, Cobalt, Oxides, Membranes, Nanofibers

The objective of this work was to investigate how cobalt doped coatings in the form of thin films and nanofiber membranes could affect the electrical response of silicon (Si) solar cells. Electro spun nanofibers and spin/dip coated thin films consisting of a polymeric solution of cobalt oxide-antimony doped tin oxide (CoO-ATO) were used as coatings on 3” x 6” Si solar cells. Polystyrene (PS) was used as a solute, and D-limonene as a solvent, to create the solution. Based on the spectral response of CoO-ATO, it is hypothesized that coatings of this material onto a solar cell can help improve the performance of the cell. CoO-ATO thin films and nanofiber membranes are coated onto a Si solar cell to synthesize a potential mat for the solar cell to filter out infrared light, thus improving the effectiveness and performance of the solar cell since it would primarily be absorbing visible light rather than infrared. Thin films are created using dip coating and spin coating techniques, and nanofiber membranes are created using an electrospinning technique. CoO-ATO has been shown to be effective in the range of 3000 nm to 5000 nm.
Asymmetric Conditions for a Symmetric Gait in a Prosthetic User

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Keywords: Mechanical Properties, Elastic Modulus, Viscosity, Viscoelasticity

It has been shown through kinematic models and use of passive dynamic walkers that lowering the knee height on a passive prosthetic below its position on the healthy leg could be favorable. Applying asymmetric conditions shows potential in helping produce a more symmetric gait in a prosthetic user. Additionally, benefits such as a lighter design and a lower center of mass to assist in the pendulum movement of the prosthetic can be made possible with designs where the knee is positioned closer to the floor. In this experiment a prosthetic knee simulator was used on a healthy subject with the knee positioned at different places with respect to the ground ranging from 32.7% the shank size of the normal leg to 44.2%. Gait data was collected in the CAREN (Computer Assisted Rehabilitation Environment) and an 11 parameter model analyzed the symmetry of the subject’s movement. This model indicated increased asymmetry for decreased heights contrary to our expectations. Specifically the moments being created in the hip and knee on the healthy leg were consistently larger. However, less variation in parameters between steps could support greater motor control as qualitatively observed by the subject.
Organic Semiconductive Coaxial Nanofiber pn Junction for Flexible Organic Semiconducting Devices

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Keywords: Organic Semiconducting Polymers, Nanodevice Fabrication, Coaxial p-n Junction

A study from Sandler Research concluded that the nanofiber market will grow at 24.12% CAGR driven by the technical industry in 2020. Part of this critical growth is driven by the need for new nano structures for organic flexible electronic devices that does not depend on silicon (Si). It is known that semiconductive nanoparticles have been used to create pn junctions in an electrospun poly-vinyl pyrrolidone (PVP) nanofiber using a hydrothermal method. In other approaches, oxide nanofibers formed tapered and twisted pn junction yarn [LOTUS] as well as metallics and polymers formed coaxial nanofibers [YANG]. High fabrication costs, oxide charging, large fiber diameters, non-biodegradability, and rigidity limit these pn junctions. To my knowledge there has never been a fundamental study conducted on the use of two organic semiconductive polymers to form a coaxial pn junction for basic electronic devices. Organic semiconductive materials electrospun into high surface area nanofibers can offer several advantages to the semiconductor industry in terms of reliability, flexibility, and tuning. I propose to fabricate and characterize an organic semiconductive coaxial nanofiber pn junction for flexible organic semiconducting devices, such as diodes, field effect transistors, and sensors. Intellectual Merit: The intellectual merit of this work is the use of organic polymeric semiconductors for efficient flexible cost effective nanodevice fabrication and behavior of a novel coaxial p-n junction.

Using a single step and efficient electrospinning process to establish a continuous fabrication methodology to produce coaxially structured nanofibers will enhance fundamental knowledge for scientists and engineers interested in nanofiber technology. The outcomes of the project will benefit the larger scientific community in organic nanoelectronics advancing the current state-of-the-art and thereby impacting the electrospinning device fabrication research arena. We hypothesized that organic semiconductive nanofiber coxials will produce pn junctions that have enhanced electronic properties and reliability, and are biodegradable, candidates for flexible electronics, receptive to crosslinking, and cost effective. More specifically, these novel organic semiconductive pn junctions have the potential to demonstrate high Ion/Ioff ratios, a reduction in leakage current, and a tunable depletion region in diode mode can be achieved. To verify this I will work to determine the formation of the depletion region by the core or shell diameter as well as applying UV radiation to study the behavior of the junction in diode mode. Also, due to the large surface area that can be generated by nanofibers in a small region, a coaxial pn junction matrix should excel in sensing capability for sensor technology.
Estimating Disease Burden from a Potential H7N9 Pandemic Influenza in the United States

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Keywords: Disease Burden, Agent-based simulation, Influenza, Pandemics

Periodic emergence of A(H7N9) influenza virus in China since winter of 2013 resulted in 770 laboratory-confirmed cases of human infections causing 306 deaths (39.75% fatality rate) till May, 2016. Researchers have developed early estimates of some of the epidemiological parameters to characterize A(H7N9) virus in China. Though most of the infection cases have been attributed to animal to human transmission of the virus, human to human transmission has been suspected in a handful of families with multiple infected members. Our goal in this paper is to assess disease burden on the U.S. in the event of an A(H7N9) pandemic outbreak.

We incorporated estimated epidemiological parameters and U.S. demographic data in an agent-based simulation model. The model mimics the A(H7N9) virus transmission process that is expected to occur during a pandemic. The model results are used to estimate disease burden. We considered non-pharmaceutical interventions as the only containment measure (without vaccines and antivirals). To reduce the computational needs of the simulation model, we first divided the 50 states of the U.S. in three clusters based on urban population density. Then, representative states from each cluster were separately simulated as outbreak areas. Infection attack rates (IARs) and the number of infected were considered as the measures of disease burden. These measures were stratified over three age-groups (≤19 yrs, 20-64 yrs and 65+ yrs).
Use of Curcumin and Glycerol as an Effective Photoinitiating System in the Polymerization of Urethane Dimethacrylate

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Keywords: Photopolymerization; Curcumin; Thermal analysis; Glycerol; Conversion degree.

The objectives of this study were to verify the viability of the photoinitiating system using curcumin as a photoinitiator and glycerol as a co-initiator, analyze the thermal and morphological features of the polymers produced, and finally evaluate the possibility of removing toxic Ethyl-p-dimethylaminobenzoate from the photoinitiating system. Curcumin, an orange-yellow dye extracted from the rhizoids of the plant Curcuma longa, is known to be a common photosensitizer, and the type II photoinitiating system consisting of a dye and an amine is long known to be effective. In recent years, the production of biodiesel has increased, and consequently, so has the generation of its main byproduct, glycerol. Thus, it becomes necessary to study and incorporate glycerol in some products.

Using thermal-analytic methods (Thermogravimetry, Differential Thermal Analysis, and Differential Scanning Calorimetry), Middle Infrared Spectroscopy, and Scanning Electronic Microscopy, it was possible to assess the thermal and morphological characteristics of the polymers produced, and compare whether the presence or lack of tertiary amine, as well as the addition of different molar ratios of glycerol, had any significant impact on these characteristics. Results suggested that neither the removal of tertiary amine nor the addition (in different proportions) of glycerol affected the thermal stability of the polymers. Also, removing the tertiary amine enhanced the total conversion degree of the polymers.
Characterization of Migration Phenotype of Pancreatic Cancer Cell Lines

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Keywords: Pancreatic Cancer Cell Lines, Acidic Microenvironment

Based on the acid-mediated tumor invasion theory, cancer cell growth is promoted in an acidic environment which is usually toxic to normal cells. The aim of this project was to investigate the impact of acidic tumor microenvironment on the migration of pancreatic cancer cell lines. Two cell lines from the same heterogeneous tumor from mice with Kras, Trp53 mutations (KPC mice) were used: UN-KPC-960 and UN-KPC-961. From pancreatic cancer literature, it is known that UN-KPC-960 represents the less acid producing cell line while UN-KPC-961 depicts the higher glycolytic cell line. The Boyden chamber migration assay was performed separately at an acidic pH of 6.8 and a normal one of 7.4 for both cell lines. Migration trends were determined based on the degree of staining in each pH condition. The extent of migration was compared. Agent-based mathematical models were generated in MATLAB using a series of differential equations to further investigate the behavior of both cell lines separately in each pH conditions. Migration rates from experimental results were used in the simulations. The models were also extended to analyze the tumor growth when both cell lines compete.

The results from our experiments and mathematical models show that not only does a normal pH record a slower tumor growth but it also promotes the growth of the less glycolytic-hence less invasive- cell line. Thus, by increasing the pH of the tumor microenvironment-possibly via bicarbonate treatment- we can potentially promote the growth of the less invasive cell line and control pancreatic cancer.
Effect of Voids on Transverse Shear Modulus of Advanced Unidirectional Composites

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**Keywords:** Composite Materials, Void Content, Design of Experiments, Finite Element Modeling, Elastic Moduli

Voids are formed inevitably as a by-product during manufacturing processes of composite materials and decline many of the mechanical properties including the transverse shear modulus. Although several analytical and empirical models are available, they are based on simple assumptions, and none of them consider the effect of voids. In this work, we estimate transverse shear modulus through finite element modeling while applying reasonable boundary conditions on a three-dimensional representative volume element (RVE). To improve the accuracy of simulating a composite model in the real world, an extrapolation technique is used to find the transverse shear modulus using multiple cells in the RVE.

Comparing the existing models to the current model for no-voids, estimated value of transverse shear modulus by the Halpin-Tsai model is found to be most accurate for low fiber volume fractions; Mori-Tanaka model had minimum error for the mid-range fiber volume fractions; while the Elasticity Approach model had high credibility for high fiber volume fractions. Looking at the effect of voids on transverse shear modulus, three primary parameters are used through a design of experiment (DOE) statistical analysis: fiber-to-matrix Young’s moduli ratio, fiber volume fraction, and void fraction.

The results indicate that the fiber volume fraction is the most dominating factor of the three and makes up to 96% contribution to the transverse shear modulus. The effects of the other two factors and combination of factors are negligible. Also, the void content has the largest contribution of 80% to the transverse shear modulus when normalized by the transverse shear modulus with no voids.

The analysis presented in this work will help in more accurate estimation of the transverse shear modulus of composite materials.
3D Printed Tactile Visualization

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Keywords: 3D Printing, Visual Impairment, Tactile Visualization

We all know that "A picture is worth a thousand words". This is especially true for complex shapes, maps and floor plans, which makes the perception of these complicated objects especially challenging for the visually impaired. In this case, when one sense is no longer available, it can be somewhat supplemented by another sense. Research has shown that spatial memory and object recognition are both accessed through the tactile senses [1]. The use of tactile visualization with the visually impaired helps stimulate their object recognition. It is only recently, as 3D printing has become a mainstream technology, that have we gotten the opportunity to create personalized tactile visualizations at low cost.

Our previous study focused on the design and 3D printing of building floorplans that can be easily understood by visually impaired, and our 3D printed maps are currently being used at Conklin Center for the Blind, in Daytona Beach, Florida [2]. Here we build upon our previous findings and introduce new and important features into these maps. We conducted live research with five residents of the Conklin Center, with the goal of determining the optimal design principles for rapid identification of emergency exits on complex maps of large buildings. We presented the printed version to the residents and teaching staff for their examination, collected detailed feedback about the different map features, and derived the optimal design specifications for such maps in the future.

References:

Mucilage Nanofibers Investigated for cell culturing

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Keywords: Electrospinning, Nanofiber, Cell Culture, Cactus Mucilage

This research involves electrospinning polystyrene and cactus mucilage solutions in varying concentrations to create nanofiber membranes that will be used to test for cell proliferation. Electrospinning involves placing a polymer solution into a syringe to which an electric field is then applied, which overcomes the surface tension of the polymer solution and form a Taylor Cone. A polymer jet is then ejected from the syringe needle tip, undergoes plastic stretching, and is deposited onto the collector as extremely thin fibers that range in diameter from nanometers to a few microns. Incorporating different substances into the polymer solution gives the resulting nanofibers different properties. Our research focuses on determining the effect of cactus mucilage gelling extract from the prickly pear plant, Opuntia ficus-indica, on cell proliferation in the nanofiber membrane for its use as wound healing.
The Effects of Tamoxifen on Auditory Temporal Processing Responses in Aging Female Mice

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Keywords: Tamoxifen, Estrogen Receptor Antagonist, Auditory Processing

The sex hormone, estrogen plays a vital role in nervous system functionality; therefore, an estrogen receptor antagonist, such as Tamoxifen, could prove to interfere with auditory processing. Tamoxifen has been shown to competitively bind to estrogen receptors, blocking the actions of estrogen, including in neural pathways of the auditory system (Thompson et al. 2006). In the present study, ovariectomized (OVX at the age of two months) female (n=4), female (non-OVX, n=5), and male (n=5) CBA mice were treated (IP injection, daily) with 20 mg/kg of Tamoxifen at 11 months of age for 14 consecutive days. ABR Gap-in-Noise testing for the three groups was performed at baseline (preOVX), postOVX 4,6 and 8 months and post tamoxifen treatment 1,2 and 3 months. Testing included a gap of silence being inserted between two noise bursts at 80 dB SPL with gap durations of 0, 1, 2, 4, 8, 16, 32, and 64 msec while mice were anesthetized. ABR data were recorded via 3 subcutaneous electrodes, and inserting a coupler inside of the ear canal to present the sound stimuli. Experimentation Results: The OVX group showed recovery ratios that decreased 5% compared to the female group at post OVX 8 months, ratios were 20% higher than control female and male groups in baseline. Baseline control female responses remained consistent and males only changed 5% over the 8 month period. After TAM treatment for the three groups, control females display lower recovery ratios, indicating reduced auditory temporal processing. The results confirmed estrogen plays an important role in auditory system temporal processing important for speech and complex sound perception.

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Corrosion Characteristics of Magnesium under Varying Surface Roughness Conditions

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Keywords: Magnesium Alloy Biodegradable Implants, Rapid Corrosion, Surface Roughness

The biggest challenge with magnesium alloy biodegradable implants is the rapid corrosion at the earlier stages of the healing process after implantation. In this research, the impact of surface roughness generated by different means on the corrosion rate of AZ31 magnesium alloy in a simulated biologic environment is investigated. In order to perform accurate experimentation, an in vitro setup is assembled that simulates the human body environment accurately has been prepared using Schinhammer’s in vitro immersion testing setup [1] and Kokubo’s Simulated Body Fluid (SBF) [2]. For the immersion test of Mg in SBF, several surface texture groups of Mg have been prepared and submerged into the in vitro tank. The Mg samples’ comparative analysis has been made in terms of corrosion rate, total weight loss and hydrogen gas evolution within a span of 7 days for the first experiment to narrow down the scope and 14 days for the follow up experiment. After 14 days of in vitro immersion test with varying roughness and hydrophobic modifications such as Cytop coating and stearic acid modification, it has been observed that the roughness group created by etching in aqueous NaCl solution for three minutes, shows better corrosion resistance compared to the polished control group. Hydrophobic modifications on the surfaces did not affect the corrosion behavior significantly.

An Interim Analysis of Body Powered Prosthetic Terminal Devices
Research Category # 3: Sensing, Networking, Communications, Computing, Biometrics and Pattern Recognition
W-band Transceiver using Additive Manufacturing

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Keywords: W-band, 3D Printing, Additive Manufacturing, 80-100 GHz, 5G, Packaging, Interconnects

The goal of the project is to design and demonstrate an 80-100 GHz Transceiver for broadband communications using Additive Manufacturing (AM). The demand for high data-rate, compact, and economical communication systems are the main driver for this project. One of the main challenges of operating at these frequencies is that interconnects and packaging at millimeter wave (mmWave) frequencies can severely change circuit performance and in fact induce electrical effects. Current state of the art systems uses waveguides, ribbon-bonds, and other complicated methods. These types of systems can be expensive, non-reproducible, or may need extensive prototyping. They also might require multiple tools to manufacture and extensive labor to ensure proper functionality. We propose solving these challenges by employing additive manufacturing to “3D-print” different dielectrics and conductors to produce multilayer PCB boards. We can pick-and-place semiconductor dies and develop novel “3D-printed” interconnects and packaging to minimize their effect on the system, or we can even utilize their effects to the system’s advantage as opposed to conventional planar and subtractive methods. This would dramatically improve the performance, reduce developmental cycles and can be highly customizable. Additionally, since 3D printing is additive by nature, this would ultimately reduce waste and be economically feasible.
5G Networking – Non-Orthogonal Multiple Access (NOMA)

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Keywords: 5G, Non-Orthogonal Multiple Access (NOMA), Orthogonal Multiple Access (OMA), Successive Interference Cancellation (SIC)

Multiple Access schemes is one important aspect of cellular system design in communications systems since it aims to allow multiple users to share the radio resources in a spectrum-efficient and cost-effective way manner. However, by next years, 5G wireless communications system will be the dominant one. The rapid development of Internet of Things (IoT) and the fast growth of mobile internet poses some challenges requirements for 5G wireless system such as spectral efficiency and massive connectivity that introduces different services with low latency and low-cost devices.

To address the requirements of 5G wireless network, non-orthogonal multiple access (NOMA) is adopted as a future radio access technology to meet the heterogeneous demands on low latency, high reliability, massive connectivity, and high throughput demands. NOMA has been introduced to solve some drawbacks of orthogonal multiple access (OMA). NOMA uses the power or code domains for multiple access and accommodates different users on the same resource (time/ frequency/code) and decodes the message using successive interference cancellation (SIC).

In my poster, more details about using NOMA in 5G systems will be presented. Also, a proposed power domain approach using NOMA is introduced and investigated to determine the optimum received power level, with SIC detection, for any number of transmitters $N$. The result is simulated using MATLAB and will be shown in the poster. The main contributions of my proposed approach are that the maximum received SINR increases linearly (in dB) with the number of users ($N$), and the design is similar to the mu-law encoding used in PCM speech companders (where the ratio of signal power to quantization noise is kept constant).
Use of an electromagnetic insulator in RF passive sensing for remote detection of blood glucose

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Keywords: RF Passive Sensing, Metamaterial Insulator, Glucose Monitoring, Battery-less Implant.

A patch antenna implanted in the body experiences a shift of resonant frequency as a function of blood glucose levels. Based on this concept, blood glucose levels could be measured by an RF passive sensing consisting of two external antennas (one for transmission and one for reception) and an implanted antenna. The external antenna sends a signal into the body towards the implanted antenna, and the signal is reflected towards the receiving antenna. One of the sources of degradation in the detection is the mutual coupling between the external antennas. The present work presents the S11 of the designed 5.8GHz patch antenna as the blood permittivity varies from 62.0 to 63.6, resulting in shift of resonant frequency from 5.7655 to 5.8889MHz, a frequency variation of 12.3MHz correspondent to 500mg/dL. Then, a comparison of the S21 between the external antennas as the distances are varied from 1mm to 20mm, and the effect of a metamaterial insulator in the results.
Diversity Maintenance in TLBO for Solving Global Optimization Problem

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Keywords: Teaching-Learning-Based Optimization, TLBO, Deceptive Function, Evolutionary Algorithm

Teaching-Learning-Based Optimization (TLBO) is a population based optimization algorithm that simulates the influence of a teacher on learners in a class. TLBO is reported to produce groundbreaking results for many constrained and unconstrained benchmark functions, and also in engineering problems. Despite its supremacy of finding the global optima, TLBO lacks of balancing the trade-off between exploration and exploitation of search space. As a result, it gets trapped into local optima or reaches the global optima after consuming a significant number of function evaluations. The situation becomes worse if the multimodal function is deceptive with several attractive basins.

TLBO never reaches in global optima for multimodal and high dimensional \((D \geq 10)\) deceptive function like Schwefel. Though numerous research works have already accomplished to improve the performance of TLBO, none of them measure its performance on deceptive functions and hence it is necessary to investigate population diversity of TLBO. In this research work, we propose to apply different diversity maintenance; initiating random immigrants, selection algorithms balancing exploration vs exploitation; in TLBO to determine the power of exploration and exploitation of search space. The assumption that less variant population fails to provide diversity in future offsprings due to the nature of crossover motivates us to inspect the dispersion of population especially in different local and global optima. Experimental results show that TLBO gets trapped on multimodal deceptive function though we increase population size from 50 to 500. Another result for one dimensional deceptive function shows that converging population fails to maintain diversity \((3.8 \times 10^{-7} \leq \sigma \leq 4.30 \times 10^{-7})\). All the experiments were performed for 30 independent trials and 500/100 generations on varying size of populations.
Physical Unclonable Function for Securing Electronic Devices

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**Keywords:** Hardware Authentication, Physical Unclonable Function

Authentication of electronic devices has become critical. Hardware authentication is one way to enhance security of a chip. Along with software, it makes it harder for an intruder to access any computer, smart-phone, or other devices without authorization. One way of authenticating a device through hardware is to use the fabrication anomalies, which are random and unclonable. This mechanism is called a Physical Unclonable Function (PUF). PUFs are easy to evaluate but hard to predict. PUF is a concept that gained popularity since the past decade, when researchers started taking advantage of the randomness of electrical signals in order to build a unique authentication block. This survey will show the state-of-the-art devices that are currently investigated as PUFs. The different technologies are compared by taking into account reproducibility, uniqueness, randomness, area, scalability, and compatibility with CMOS. Emphasis is put on technologies that are emerging and gaining commercial interest. Through comparisons, we will show their applicability to different environments.
Improving malignancy prediction through feature selection informed by nodule size ranges in NLST

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Keywords: Non-Small Cell Lung Cancer, Malignancy Prediction, Nodule Size

Computed tomography (CT) is widely used during diagnosis and treatment of Non-Small Cell Lung Cancer (NSCLC). Current computer-aided diagnosis (CAD) models, designed for the classification of malignant and benign nodules, use image features, selected by feature selectors, for making a decision. In this paper, we investigate automated selection of different image features informed by different nodule size ranges to increase the overall accuracy of the classification. The NLST dataset is one of the largest available datasets on CT screening for NSCLC. We used 261 cases as a training dataset and 237 cases as a test dataset. The nodule size, which may indicate biological variability, can vary substantially. For example, in the training set, there are nodules with a diameter of a couple millimeters up to a couple dozen millimeters. The premise is that benign and malignant nodules have different radiomic quantitative descriptors related to size. After splitting training and testing datasets into three subsets based on the longest nodule diameter (LD) parameter accuracy was improved from 74.68% to 81.01% and the AUC improved from 0.69 to 0.79. We show that if AUC is the main factor in choosing parameters then accuracy improved from 72.57% to 77.5% and AUC improved from 0.78 to 0.82. Additionally, we show the impact of an oversampling technique for the minority cancer class, in some particular cases from 0.82 to 0.87.
Overhead Squat Assessment of Physical Therapist Patients for Rehabilitation Purposes

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**Keywords**: Physical Therapy, Overhead Squat Assessment

This paper proposes an approach that can compute the angles from lower limbs while a physical therapist patient is performing an overhead squat. Five Shimmers IMU (Inertia Measurement Unit) placed in selected regions will be used to collect data. The approach uses Multi-Layer Perceptrons (MLPs) alongside decision trees to perform the calculation of the angles of each sensor with respect to a chosen axis. From calculating theoretical measurements to experimental measurements, the least mean-squared error of the MLPs is 0.050683607, decreasing the error obtained on a previous approach (3.45713575). The error is calculated measuring the angles using a goniometer and comparing it to the values extracted from the propose approach.
Effects of Tag Estimation on RFID System Efficiency

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Keywords: RFID, Tag Estimation, Anti-collision, Channel Efficiency, EPC C1G2

Radio frequency identification (RFID) systems are increasingly used for a wide range of applications from supply chain management to healthcare to retail. In a typical RFID system, a reader (interrogator) communicates with tags (transponders) for information exchange. If multiple tags try to communicate with the reader at the same time, a collision occurs leading to failed communications and the consequences are wasted bandwidth, reduced identification speeds, and lower overall system efficiency. As the number of RFID tags in circulation continue to increase exponentially, researchers turn to tag estimation techniques which have been studied extensively in the literature with a variety of algorithms specifically designed for low-power passive RFID systems.

Passive RFID systems allocate their channels using a time-division-multiplexing technique called ALOHA where each tag in the environment randomly chooses a synchronized time slot in a communication frame of adjustable size. In such a probabilistic framework, the researchers have previously shown that the ideal frame size is equal to the number of tags trying to communicate with the RFID reader. As a result, an accurate way of estimating the number of tags in the environment would improve system efficiency and read speeds. In this work, we propose a simulation-based approach which integrates various tag estimation algorithms from the literature within the industry standard EPC Class 1 Generation 2 (EPC C1G2) protocol framework. Using the simulation tool we have developed, we analyze the effects of tag estimation on system efficiency for passive RFID systems. The modifications to the EPC C1G2 protocol are made at the dynamic frame size update stage where the next frame size is determined after the algorithms estimate the number of tags in the environment. This tool can be used to identify how to best utilize tag population data coming from different estimation algorithms by i) comparing their accuracies and ii) correlating these accuracies with corresponding improvements in system efficiency to have a much more comprehensive assessment than what is currently available in the literature.
MM-Wave High Gain Beam-Scanning Focal Plane Arrays with Microfluidically Switched Feed Networks

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Keywords: Beam-Scanning Microfluidic Focal Plane Array, RF devices

Microfluidic based reconfiguration techniques are promising for realizing low-loss, low-cost, and high power handling RF devices. However, rapid oxidization and an order of lower conductivity of liquid metals pose issues for their reliable use and applicability at higher frequency bands. Our recent work removed these issues by utilizing selectively metallized plates within the microfluidic channels. This technique already allowed to realize devices that handle high power, exhibit wide frequency tuning range, and operate in mm-waves.

This presentation will focus on our beam-scanning Microfluidic Focal Plane Array (MFPA) concept (A. A. Gheethan and G. Mumcu, “Passive Feed Network Designs for Microfluidic Beam-Scanning Focal Plane Arrays and Their Performance Evaluation,” IEEE Transactions on Antennas and Propagation, vol. 63, no. 8, pp. 3452 – 3464, Aug. 2015) by introducing a novel feed network to further enhance its efficiency, bandwidth, and beam-scanning speed. The proposed microstrip line feed network lies under a focal plane aperture coupled 30 GHz patch antenna array and utilizes a selectively metallized plate within the microfluidic channel to perform RF switching functionalities. The switching is achieved by using a 6um thick low loss benzocyclobutene layer as the microfluidic channel wall to realize strong capacitive coupling between the metallized plate and microstrip line feed network. Individual switch design and characterization shows that the insertion loss of each switch can be kept below 0.2 dB. Hence, multiple switches in series can be utilized to develop a convenient feed network topology that would also operate over a significantly wider bandwidth as compared to our prior work which relied on resonance mechanisms. The presented feed network allows a highly efficient beam-scanning high gain antenna that is free from the costs and design complexities associated with the need of including active RF devices. In addition to the design details, the presentation will also report recent experimental verifications of the proposed microfluidically actuated switch, feed network, and MFPA. Design techniques/approaches that can be utilized to extend the MFPA concept to achieve 2D beam-scanning will also be discussed.
A Strong Arbiter PUF using Resistive RAM within 1T-1R Memory Architecture

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Keywords: Physically Unclonable Function, Resistive RAM, Hardware, Security, Non-volatile Memory

In this poster a strong arbiter Physically Unclonable Function (PUF) implementation is presented. Cybersecurity is becoming a growing concern with evolution of Internet-of-Things (IoT). The conventional cybersecurity techniques are devoted to secure the upper layer of software stack assuming the underlying hardware to be secure. However, that assumption is not true anymore and hardware itself is subjected to variety of attacks such as cloning, reverse engineering, Trojan insertion, side channel attack, recycling/counterfeiting and so on. New methodologies are being developed to ensure the security and integrity of hardware systems. PUF is one of the widely accepted hardware security primitives that finds application in authentication as well as random number generation. It generates a secured key by the physical nature of an electronic system. Physical structure of every electronic system is unique due to inherent differences during manufacturing by the same process technology. The existing RRAM PUFs are weak due to linear number of CRPs. Extension to strong PUFs (such as arbiter PUF) while staying within the array structure is a non-trivial problem due to requirements such as arbiter circuits and multiplexers.

With growing research in the area of non-CMOS technologies for memories and circuits, it is important to understand their implications on the design of security primitives. Resistive Random Accessible Memory (RRAM) offers easy integration with CMOS due to minimal changes in the process technology. RRAM also demonstrates resistance variability characteristics due to inherent defects in the conducting filament formed inside the metal oxide layer. RRAM based PUF designs exploit either the probabilistic switching of RRAM or the resistance variability during forming, SET and RESET processes. Memory PUFs using RRAM are typically weak PUFs due to fewer number of Challenge Response Pairs (CRPs). We propose strong arbiter PUF based on 1T-1R bit cell which is obtained from conventional RRAM memory array with minimally invasive changes. Conventional voltage sense amplifier is employed to generate the response. The PUF is simulated using 65nm predictive technology models for CMOS and Verilog-A model for a hafnium oxide based RRAM. The proposed PUF architecture is evaluated for uniqueness, uniformity and reliability and by running NIST benchmarks. It demonstrates mean intra-die Hamming Distance (HD) of 0.13% and inter-die HD of 51.3%, and, passes the NIST tests for randomness.
Towards the Realization of Human Core Body Temperature Extraction using a Standalone Radiometric Mode

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Keywords: Wireless Thermometer, Human Core Body Temperature

This work overviews the technical advances made toward the realization of a wireless thermometer able to non-invasively, wirelessly, and accurately predict sub-skin human core body temperature with an accuracy of 0.1°C. A standalone microwave radiometric model, used to resolve subsurface temperature, is experimentally validated. The extracted sub-skin temperature of a human body tissue phantom experimental setup is predicted with a 0.25% difference from measured temperature probes positioned within the phantom setup. The modeled versus measured data agreement suggests that the presented modelling approach is indeed a viable method for accurate subsurface human core body temperature extraction. Technical contributions are achieved for the antenna design, the modelling of the radiative transfer within the body, and also for the tissue phantom development.
Embedded 6 GHz 3D-Printed Half-Wave Dipole Antenna

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Keywords: 3-D Antenna, Dipole, GCPW Balun, 6 GHz, Roughness.

In this work a 3-D packaged, half-wave dipole antennas are employed to design a 3-D 2×2 array. Single element design includes a grounded coplanar waveguide (GCPW) balun that is printed on an inclined surface and used to connect the 50 ohm feed line on the lower layer to the dipole on the top layer. For matching purposes, a GCPW quarter-wave transformer is incorporated between the 50 ohm feed line and the balun. The 6 GHz half-wave dipole is approximately λ/4 above the ground plane. Adopting the 3-D element facilitates designing the array feeding network and enhances the overall array response. Fabrication is done using the direct digital manufacturing technique with an acrylonitrile butadiene styrene (ABS) substrate (relative permittivity of 2.7 and a loss tangent of 0.008) and Dupont CB028 silver paste. Antenna substrate surface roughness is analyzed to explain discrepancies between simulation and measurement results. The 3-D array structure provides advanced capabilities that are hard to meet using the planar array structure, as well as more space underneath the array for the electronics (amplifier, filter).
Ku-band RF Devices using 3D Additive Manufacturing

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Keywords: Additive Manufacturing, 3D Printing, Ku-band, Embedded Systems, Antenna, Connector

Embedded/integrated systems and SoP applications can provide low-cost, compact solutions through the efficient use of space. These systems can be fabricated using additive manufacturing (AM). This offers increased design customization, reduction in the design cycle, and flexibility. AM of RF devices enables designers to create unique structures/geometries by varying the infill percentage, resulting in variations in the dielectric constant.

In the research presented, a Ku-band wideband dual-linear aperture-stacked patch antenna with polarization switch and Ku-band connector using AM are introduced. Varying infill percentage of ABS layers achieves bandwidth extension and weight reduction. The whole structure is printed in complete (one-pass) manufacturing. Fully-printed multi-layer unit cells at lower microwave frequencies have been accomplished previously; however, the effect of surface roughness and conductivity at higher microwave frequencies are challenging. Using microstrip lines and single patch antennas on ABS and Kapton, skin depth effect and conductivity of the silver conductor at Ku-band are characterized. Also, to improve multilayer adhesion and to decrease the printing time and cost, meshed and solid ground CPWG are compared. A Ku-band connector design is modeled in high frequency 3D simulation software. Design of a coaxial-to-microstrip transition improves the reflections due to the discontinuities, while also improving the modal mismatch between the two transmission lines.
Auto-clustering Output Layer for Deep Neural Networks

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Keywords: Deep Neural Networks, Auto-clustering

After years of shortcomings, artificial neural networks have finally found their footing in deep learning. Through an ever expanding ecosystem of powerful hardware and software tools, thousands of interconnected neurons can now feed on data available in massive quantities and succeed in rivaling the most sophisticated human engineered systems in many recognition tasks. In this paper, we introduce a novel and simple yet effective modification to the output layer design of neural network classifiers. The proposed auto-clustering output-layer exploits the class inclusion capabilities of deep neural networks to spontaneously form subsets (clusters) under the main class labels with no explicit instructions during training. Comprehensive mathematical and experimental analyses on popular image datasets show how, unlike a traditional network, the activation functions at the proposed output layer become adaptive to input patterns and create clusters with visually similar and identifiable features. Furthermore, comparative tests on three of the most popular image datasets using both deep convolutional neural networks and feed-forward multi-layer perceptron topologies demonstrate robustness of the auto-clustering output-layer through higher classification rates with increasing levels of dataset complexity. Finally, the findings in this paper hold remarkable potential for scientific data exploration, especially on large, non-uniform collections, by deploying the power and versatility of deep supervised learning for unsupervised categorization over expert-labeled classes.
Hierarchical Networking in WBANs and 5G

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**Keywords:** Energy Efficiency, WBANs, Optimization, Hierarchical Networking, 5G

In multi-tiered 5G Heterogeneous Networks (HetNets) and Wireless Body Area Networks (WBANs), resource allocation, optimization, and load balancing are important, challenging tasks. We designed two algorithms, Cross Layer Optimization for Energy Efficiency (CLOEE) and Energy Efficiency Optimization with Channel Access Probabilities (EECAP), to determine the optimal solution that maximizes the energy efficiency with a variety of the constraints in WBANs. Both algorithms can be extended to 5G and Internet of Things (IoT).
Low Permittivity Cladding to Improve the Performance of Dielectric Rod Waveguides and Dielectric End-Fire Antennas

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**Keywords:** Additive Manufacturing, Dielectric Rod Waveguide, End-Fire Antenna, Ku Band, Rectangular Waveguide.

A low loss dielectric rod waveguide (DRW) design is proposed for use at Ku band. Measured waveguide performance from 10 to 18 GHz is presented and validated using full wave numerical simulations. A low loss dielectric rod waveguide (DRW) design that employs a low permittivity cladding to improve performance at the low end of the operating frequency band is proposed, resulting in a 16.7% and 24% increment of the 1 dB cut off frequency for a 10 × 10 mm² and 20 × 20 mm² respectively. The low permittivity cladding is also exploited to reduce the radiation in the DRW bends. The proposed ABS cladding is also implemented on a dielectric end-fire antenna obtaining an improvement in return loss, gain and half power beamwidth at the low end of the Ku band. The measured peak gain at 12.2 GHz is 14.6 dBi and 9.8 dBi with and without the cladding, respectively, and the 3 dB beamwidth changes from 61 to 22 degrees due to the ABS cladding. Additionally, for all frequencies within the band, end-fire peak gain improvements ranging from 4dB to 7 dB are achieved by adjusting the applied loading to the antenna. Particularly, permittivities of εᵣ = 2.6 and εᵣ = 1.6 create peak performances at 12 GHz and 18 GHz, respectively. A modified ABS cladding with εᵣ = 1.625 is fabricated, showing a measured return loss greater than 10 dB within the band, and an end-fire peak gain of 16.2 dBi at 17.2 GHz. A reduction in 3 dB beamwidth from 48 degree down to 28 degree is also observed due to the presence of the cladding.
Using Local Power Price to Manage Multi-Tenant Data Center Performance and Energy

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Keywords: Local Power Price, Multi-Tenant Data Center, Oversubscription, Power Capping

Multi-Tenant Data Center (MTDC) operators can increase their profits as well as overall power utilization by oversubscribing the number of hosted servers for a given overall peak power consumption limit. This can occasionally lead to problematic situation where the total power consumption is over the limit, possibly causing expensive unplanned downtimes. To overcome this problem, we propose the use of local price for power as a means of managing the energy use of an oversubscribed MTDC. Local price is set by the operator to reflect the current power demand. Individual tenants use the current local price set by the operator, their current workload and Service Level Agreement (SLA) performance measure, to determine how many servers should be awake at a given time.

In this poster, we present a real-time local power pricing algorithm based on an optimization approach where our objective is to maximize aggregate tenant utility while making sure that total power consumption does not exceed capacity. Tenants consume power to maximize their own profit while the operator uses local price to coordinate tenant decision. We evaluate our method using workload modeled as time varying poisson process extracted from real data center traces. Simulation results show that our method benefits both the tenants and the operator compared to a fixed pricing scheme, while achieving our goal of keeping the total power consumption under the limit.
5G Networking - Increasing Physical Layer Security

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**Keywords:** 5G/IoT, Physical Layer Security, Space-Time Block Coding (STBC)

Searching for the perfect secrecy in communication systems has been the interest of researchers since Shannon introduced the mathematical theory of secret communication in 1948. Most of the communication systems are equipped with so-called computational based security approaches (cryptographic methods), which introduce computational advantages for the legitimate users over the adversaries. In contrast, physical layer security techniques have no assumption on adversary's computational power. In this poster, we present a physical layer methods complement and enhance the security of the current cryptographic methods used in the upper layers of the protocol stack of 5G/IoT networks. The common physical channel between end points (Alice and Bob) is exploited to establish a secure key. This key is then used as a one-time pad to randomize Space-Time Block Coding (STBC) communications between Alice and Bob and ensure a low probability of intercept by the eavesdropper (Eve).
Design and Application of Passive and Active Sensors for Security Scanners

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Keywords: Passive and Active Sensors, Security Scanners

This work focuses on the simulation and design of a security sensor that combines active (radar) and passive (radiometer) measurements for increased functionality with the aim of developing a 3D printed, handheld, millimeter wave (94 GHz) security sensor in the future. Prototype radar and radiometric systems in the K band (18-26 GHz) are designed to validate the concept that the two modes offer complementary information about the target thereby alleviating the need for stringent imaging resolution requirements that exist in extant millimeter wave security systems to detect contraband.

For the experiment, two test samples - a Rogers RT Duroid 5880 of dimensions 9 in. x 6 in. x 0.125 in. and a metal sheet of dimensions 4.2 in. x 4.2 in. - are selected. Through radar measurements, it was observed the samples have identical radar cross sections and are therefore indistinguishable in their radar signatures when placed at the same distance from the radar antennas. However, due to differences in material properties, the brightness temperatures of the two samples differ by about 17 K when the samples are cooled to a temperature of 40 F.

This difference in brightness temperature is easily detectable on the radiometer. Therefore, by combining data from the two measurements, the position and material property of the target are estimated providing sufficient information to detect and distinguish concealed items. Additionally, the design of a 3D printed millimeter wave lens antenna fed by an aperture coupled patch is presented. This 2 cm diameter lens is designed at 30 GHz and offers a gain of 16 dB. 3D printing the lens antenna will allow for rapid prototyping and easy integration with the security sensor.
Deep Feature Transfer Learning in Combination with Traditional Features Predicts Survival among Patients with Lung Adenocarcinoma

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Keywords: Lung Cancer Survival, Convolutional Neural Network

Lung cancer is the most common cause of cancer related deaths in the US (1). It can be detected and diagnosed with the help of computed tomography (CT) images. For an automated classifier, identifying predictive features from medical images is a key concern. Deep feature extraction using pre-trained convolutional neural networks has recently been successful when applied in some image domains. In this paper, we applied a pre-trained convolutional neural network (CNN) to extract deep features from 40 CT images, with contrast, of non-small cell adenocarcinoma lung cancer, combined deep features with traditional image features and trained classifiers to predict short and long term survivors. We experimented with several pre-trained CNNs and several feature selection strategies.

The best previously reported accuracy while using traditional quantitative features was 77.5\% (2) (AUC 0.712) and was achieved by a decision tree classifier. The best reported accuracy from transfer learning and deep features was 77.5\% (3) (AUC 0.713) using a decision tree classifier. When we combined extracted deep neural network features along with traditional quantitative features we obtained an accuracy of 90\% (AUC 0.935) with the five best post-relu features extracted from a vgg-f pre-trained CNN and the 5 best traditional features. The best results were achieved with the symmetric uncertainty feature ranking algorithm followed by random forests classifier.

References
Novel Wireless Integrated Vectorcardiogram (iVCG)

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\textbf{Keywords:} Vector Cardiogram, Wireless Medical Device

The Integrated Vectorcardiogram (iVCG) is an ambulatory, compact on-body, diagnostic-quality device that continuously monitors the electrical activity of the heart in three dimensions, with leads in the X, Y and Z dimensions. Wireless connectivity to provide 24x7 data is integral to the iVCG. This capability has never existed before. The information content is the same as that obtained from the 12-lead ECG. Currently, the VCG, which was invented in the 1930’s, is mostly used for didactic purposes to teach students of biomedical sciences physiological aspects of electrocardiography.
3D Printed On-Package Tripolar Antennas for Mitigating Harsh Channel Conditions

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Keywords: 3D Printed, Tripolar Antenna, Harsh Channel Conditions

A compact, 3D printed tripolar antenna operating at 2.4 GHz is presented. The antenna is designed for integration with a commercial wireless node in order to mitigate multipath and depolarization channel effects that could exist in many machine-to-machine deployments. The antenna substrate is fabricated with fused deposition modeling and the conductive layers by micro-dispensing silver paste. A median channel loss reduction of 4.3 dB is achieved in a Rayleigh fading environment using selection diversity.
Monolithic Meshed Reflector Antenna Including Filter and Feed: fabricated with Binder Jetting 3D Printing

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**Keywords:** Additive Manufacturing, Binder Jetting, Parabolic Reflector, Reflector Antenna, Waveguide, Ka-band, 3D Printing.

Successful demonstrations show that Additive Manufacturing (AM) can be used to fabricate high-performance microwave circuits and antennas. It is enabling new geometries that either offer improved performance, or an advantage in cost or weight, and that would be hard to manufacture with traditional machining. In the particular case of reflector antennas, they are traditionally made by joining several pieces (i.e. reflector, illuminating horn antenna, feed, etc.), which increases the risk of failure; especially when the antenna is subject to intense vibrations like the ones during satellite deployment, or on a ground vehicle. In this work, the concept of a monolithic meshed reflector antenna that includes the reflector, illuminating antenna, waveguide feed, and filter (all in one piece) is introduced; where the conductor usage is reduced 40% by meshing the reflector while having minimal effect on the performance. This antenna is fabricated using binder jetting 3D printing; has a realized gain of $\sim 29.5$ dBi at $32 \text{ GHz}$, a diameter of $155 \text{ mm}$, and a bandwidth of $2 \text{ GHz}$. 
Multi-Omic Network Analysis (MONA) - A New Tool for Integrative Analysis

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Keywords: Integrative Analysis, Multi-Omic Networks, Differential Expression, Bioinformatics

Integrative analyses can give a synergistic view of biological processes since they allow for the simultaneous utilization of multi-omic datasets. However, complexity, technological and computational limitations, small sample size, and a large number of biological variables make integrative analyses very challenging. Here, we present Multi-Omic Network Analysis (MONA), a network-based tool for integrative omic analyses. MONA uses a greedy search algorithm to build differentially expressed subnetworks using experimental data from different molecular types combined with known molecular interactions mined from the STRING and STITCH databases.

The MONA search algorithm can weight the confidence of the molecular interactions so that false positive networks are less likely to be identified. MONA uses nonparametric, rank-based scoring, allowing it to handle multi-omics data from separate experiments that differ in scale. MONA assigns p-values to differentially expressed networks by random sample permutations, and false discovery rate is controlled by the Benjamini-Hochberg procedure. MONA is implemented in Galaxy, a widely used open source and web-based platform for biomedical research. MONA can output resulting differentially expressed subnetworks as tables or as XGMML for direct import into Cytoscape. We have used MONA to analyze proteomics and metabolomics data on different histological types of lung cancer, and MONA was able to identify significantly differentially expressed subnetworks related to glycolysis and nucleotide metabolism, which may represent novel vulnerabilities in small cell lung cancer. The MONA framework was designed with extensibility in mind, so additional databases and new molecular types can be added with minimal effort. Future directions include support for different search algorithms (co-expression; Bayesian) and support for post-translational modifications from proteomic experiments.
Evolutionary Algorithms for Fitness Caching

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Keywords: Evolutionary Algorithms, Calculating Fitness

Evolutionary Algorithms - EAs - are bio-inspired search and optimization techniques which have served as metaheuristics in a wide variety of applications for which full mathematical modelisation of the problem, provably efficient algorithms, or even provably convergent algorithms, are not yet available. As such they have been a valuable component of any optimization and search toolkit. They use the concept of selection, mutation and crossover to find a fitter individual which is a candidate solution in this case. Calculating fitness is the most expensive computation in an EA. So, our idea is to perform fitness caching so that we can reuse the calculated fitness of the individuals. As an evolutionary algorithm runs, the diversity of the population decreases after a number of generations which may cause the algorithm to converge to a local optimum. So, it is very necessary to maintain diversity in the population. As, diversity is introduced in the population, there will be newer individuals. So, it will need automatically need more evaluations for calculating the fitness of the individuals. If we can use the diversity that is generated from the fitness cache, then there will be no expensive computations needed for improving the evolutionary algorithms with diversity management.
5G Networking – Diversity Coded Software Defined Networks

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**Keywords:** 5G, Diversity Coding, Software Defined Network.

Software Defined Network (SDN) is an emerging networking technology based on “off the shelf” multi-vendor equipment that enhances network performance by decoupling routing control from the physical infrastructure. The separation of the data plane from the control plane enables easy “middlebox” (Firewalls, Intrusion Detection Systems, and Network Address Translators) integration. 5G networking paradigms depend on software-based technologies such as SDN and Network Function Virtualization (NFV). However, recovery from a link failure is an important problem since link failure significantly increases latency, which should be minimal to match 5G requirements, and decreases network reliability. To address this problem, we propose to use Diversity Coded SDN which offers very high reliability and robustness against link failures, near-instant recovery (no rerouting), and an efficient platform for launching customized services.
Formation Control with Multiplex Network

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Keywords: Distributed Control Architectures, Unmanned Aerial Vehicle Formations

Current distributed control methods have a lack of network infrastructure to enable spatially evolving unmanned aerial vehicle formation necessary for application in cluttered and dynamic environments. These methods are based on distributed communication rules represented by a single-layer network, which leads to multivehicle formations having fixed spatial (e.g., network geometric shape) properties. For situations where capable (leader) vehicles have to alter such properties, they can do so if such vehicles have global information exchange ability. However, this is not practical for cases involving large numbers of unmanned aerial vehicles and low bandwidth communication constraints. Motivated from this standpoint, my research objective is to establish distributed control architectures for unmanned aerial vehicle formations such that capable vehicles can alter the resulting formation through local communications to adapt cluttered and dynamic environments when necessary. To achieve this objective, I will utilize multiplex networks – a recently emerging theory in physics and network science – and use differential potential field framework. Specifically, we will model the interaction between capable vehicles and their neighbors using multiple-layers to achieve spatial formation evolution through local communications, and resort to differential potential field framework for collision avoidance and connectivity maintenance during a mission.
Compliant Force Sensor for Robotic Control of Contact Forces

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Keywords: Compliant Force Sensor, Robotic Force Control, Orthoplanar Spring

A compliant force/torque sensor for robotic force control has been developed. The sensor uses an orthoplanar spring equipped with Hall effect sensors in order to measure three axes of force/torque. Its unique design allows for simple and cost effective manufacturing, high reliability, and compactness. The device may be used in applications where a robot must control contact forces with its environment, such as in surface cleaning tasks, manipulating doors, and removing threaded fasteners. The compliant design of the sensor improves force control performance and reduces impact forces. Theoretical compliance and stress analysis of the orthoplanar spring that allows for rapid design calculations is presented. Finite element analysis results are presented for a variety of design parameters and compared with the theoretical compliance and stress analysis equations. The processing of Hall effect sensor signals to obtain accurate 3-axis displacement measurements is developed and guidelines are given for the placement and selection of Hall effect sensors. A mechanical design method is presented, which includes design for a specified footprint and design of the mechanical limits. A prototype in the making is presented and discussed.
Training a UAS to Predict the Probability of Collisions

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Keywords: Unmanned Aerial System, Neural Network, Time-to-Contact, Collision Detection

Small, unmanned aerial systems (UASs) require onboard sensors to autonomously navigate and detect obstacles within complex environments such as wooded areas, which are locations that contain many trees and other vegetation. However, small UASs, which are one meter or less in diameter, have limited carrying capacity, which restricts the number of sensors they can carry. Also, since outdoor navigation may require long endurance flights and small UASs have limited battery life, using power-hungry sensors such as laser range finders is not feasible. Thus, small UASs are usually limited to an onboard RGB camera. This research proposes a neural network-based, obstacle detection system that uses video from a robot’s onboard camera and a biologically-inspired, collision detection mechanism called time-to-contact to predict the probability that a robot will collide with an oncoming obstacle (such as a tree). This poster discusses how a neural network is being trained to predict a collision probability.
An Approach for Automated Multimodal Analysis of Infants’ Pain

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Keywords: Pain Assessment, Optical Flow, Motion Image, Pain Expression, Multimodal, Unimodal

In this research, a machine-based multimodal approach is presented that observes several indicators of infants’ pain and provide a continuous and standardized assessment.

Current practices of assessing infants’ pain depend on the observer’s subjective and potentially inconsistent judgment and requires continuous monitoring by care providers. Therefore, pain may be misinterpreted or totally missed leading to misdiagnosis and over/under treatment. To address these shortcomings, current practices can be augmented with a machine-based assessment system that monitors various pain cues and provides an objective and continuous assessment of pain. Although several machine-based pain assessment approaches have been introduced, the majority of these approaches assess pain based on analysis of a single pain indicator (i.e., unimodal). In this paper, we propose an automated multimodal approach that utilizes a combination of both behavioral and physiological pain indicators to assess infants’ pain. We also present a unimodal approach that depends on a single pain indicator for assessment. Recognizing pain using a single indicator yielded 88%, 85%, and 82% overall accuracies for facial expression, body movement, and vital signs, respectively. Combining facial expression, body movement, and changes in vital signs (i.e., the multimodal approach) for assessment achieved 95% overall accuracy. These preliminarily results indicate that utilizing both behavioral and physiological pain indicators could provide a better and more reliable assessment of infants’ pain.
Research Category # 4: Other
The Impact of Healthcare-Related Workshops on Student Motivation and Retention in Engineering

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Keywords: Healthcare, Out-of-Class Interventions, Diversity, Workshops, Survey

The purpose of Project IDEAL (Increasing Diversity in Engineering Education and Labor Force) is to enhance students’ knowledge of the healthcare applications while inspiring female students to complete their degree and pursue careers in engineering. Currently, only 19.2% of engineers are female who are enrolled in the science and engineering programs according to the National Center for Science and Engineering Statistics. Thus this project has aimed to incorporate pedagogical interventions in the areas of healthcare to promote the students’ scientific understanding while being engaged at the same time. We will analyze the impact of out-of-class interventions focused on healthcare applications on student motivation and retention in engineering. We hypothesize that students can be motivated in their engineering educations and career by exposing them to real-life applications of engineering in healthcare, especially if they are female students. We conducted two workshops where students interacted with professional engineers working in the healthcare field. The panelists shared their inspirations, obstacles, and achievements, and performed an interactive case study session based on their fields of work for students to address in teams. Each workshop was provided to a different student audience yielding different results. Workshop 1 was provided to students who have previously expressed interest in the topic of healthcare engineering, while some of the students that attended Workshop 2 had never shown previous interest about healthcare engineering. We utilized surveys to administer at the end of each workshop in order to measure the results. Wilcoxon Signed Rank test was performed to determine whether the students had favorable perceptions regarding the workshops while Mann-Whitney U-Test was used to test if there was a significant difference between responses from students based on gender. Results demonstrate that the proposed out-of-class interventions showing the connection between engineering and healthcare can increase student motivation in engineering, and are equally effective on students regardless of gender.
Virtual Reality Locomotion Techniques for Room Scale Tracked Areas for Neurotypical and ASD Populations

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Keywords: Virtual Reality, Locomotion, Room Scale Tracked Areas, Neutotypical, Autism Spectrum Disorder, Rehabilitation

In the recent years, virtual reality has been used as an effective tool for a wide range of areas such as training, rehabilitation, education and games. Since virtual reality is a different technology than the widespread computer systems, different design principles may be required for better user experience. One of the crucial components of virtual reality applications is locomotion, since locomotion is used for moving the viewpoint of the user in virtual environments and the user’s viewpoint is very important in immersing the user into virtual reality. Several previous studies investigated virtual reality locomotion techniques for neurotypical individuals. However, many of these techniques were evaluated in large tracked areas while today’s new generation of virtual reality systems can only track room scale environments. On a different note, several previous studies concurred that virtual reality is an effective medium for training and rehabilitation of individuals with ASD. However, no previous study to our knowledge evaluated locomotion in virtual reality for this specific population. In this poster, a study investigating eight different locomotion techniques in room scale tracked areas for neurotypical individuals and individuals with Autism Spectrum Disorder is presented. Design, implementation and the key findings from a user study with 16 neurotypical participants and 15 participants with high functioning ASD are presented.
Virtual Reality Applications for individuals with Autism Spectrum Disorder

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Keywords: Virtual Reality, Autism Spectrum Disorder (ASD), Neurotypical

In this poster, three experiments that aim to investigate better design considerations for virtual reality applications targeting individuals with Autism Spectrum Disorder (ASD) are presented. The following five virtual reality properties were examined in the experiments: effects of instruction methods on user performance with virtual reality warehouse tasks, effects of visual fidelity and view zoom on user performance with a virtual reality investigation task, and effects of environmental clutter and motion on user performance with a virtual reality searching task. The three experiments were evaluated with user studies with 15 neurotypical and 15 high functioning ASD individuals. Although virtual reality was proven to be a promising tool for individuals with ASD by many previous studies, effects of virtual reality properties on user experience of this population is still an unexplored area. This poster presents the experiment design and salient user study results, with the aim of leveraging future virtual reality training applications targeting high functioning individuals with ASD.
Impact Force Reduction Using Variable Stiffness with an Optimal Approach for Jumping and Falling Robots

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Keywords: Humanoid Robotics, Vertical Jump, Soft Landing, Soft Contact.

Some important applications of humanoid robots in the nearest future are elder care, search and rescue of human victims in disaster zones and human machine interaction. Humanoid robots require a variety of motions and appropriate control strategies to accomplish those applications. Using a similar approach of human robot interaction, where force sensors are used to implement better control of interaction force. This research has been conducted with the aim of developing a control strategy to produce soft impact in the landing phase for jumping and falling robots. An algorithm is proposed using motors with compliant capabilities; a control strategy is applied to reduce the impact force in the landing phase of the jump process or when the robot is falling. Reduction of impact force was tested by simulations, custom made robot and commercial humanoid robot. For every case the algorithm provided a good reduction on the impact force.
A two-stage criterion space search algorithm for bi-objective Integer Programming

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Keywords: Multi-objective Optimization, Integer Programming, Two-Stage Algorithm

Many real world-problems involve multiple objectives. Due to conflict between objectives, finding a feasible solution that simultaneously optimizes all objectives is usually impossible. Thus, generating many or all efficient solutions, i.e., solutions in which it is impossible to improve the value of one objective without a deterioration in the value of at least one other objective, is a primary goal in multi-objective optimization. We study a class of multi-objective optimization problems, the so-called bi-objective integer programming problems. In this class of optimization problems, there are only two objectives, all constraints and objectives are linear, and the decision variables are integer.

The purpose of this work is to combine two of the most effective (criterion space search) algorithms, the Balanced Box Method (BBM) and ε-constraint method, to be able to employ advantages of both. BBM is the fastest algorithm known for solving bi-objective integer programs, but it needs to solve more single-objective integer programs than the ε-constraint method. We find out that during the course of BBM, it will solve many redundant single-objective integer programs at its late stages. Our proposed two-stage method will avoid this drawback, and therefore it can result in solving bi-objective integer programs faster.
On Transient Performance Improvement of Adaptive Control Architectures

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Keywords: Uncertain Dynamical Systems, Stabilization and Command Following, Adaptive Control, Transient Performance Improvement

While adaptive control theory has been used in numerous applications to achieve given system stabilization or command following criteria without excessive reliance on mathematical models, the ability to obtain a predictable transient performance is still an important problem -- especially for applications to safety-critical systems and when there is no a priori knowledge on upper bounds of existing system uncertainties. To address this problem, this poster presents a new approach to improve the transient performance of adaptive control architectures. In particular, this approach is predicated on a novel controller architecture, which involves added terms in the update law entitled artificial basis functions. These terms are constructed through a gradient optimization procedure to minimize the system error between an uncertain dynamical system and a given reference model during the learning phase of an adaptive controller. A detailed stability analysis of the proposed approach is provided as well as a discussion of the practical aspects of its implementation.
Circular Orbit Transfer Using Approximate Higher-Order Transformations and State Feedback

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Keywords: Circular Orbit Transfer, Feedback Linearization

An approximate feedback linearization for the multi-input, multi-output circular orbit satellite problem is presented. The coordinate transformation and feedback parameters are computed symbolically. We found functions and relations between transformation parameters for the circular orbit satellite problem. We also showed with applying higher-degree feedback, the stability in state response was improved.
Suitability of Mold Species for Bioleaching Assessed Li and Co Tolerance

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Keywords: Fungal Bioleaching, Li and Co Tolerance

An environmentally friendly fungal bioleaching process using organic acids produced by \textit{Aspergillus niger}, \textit{Penicillium chrysogenum} and \textit{Penicillium simplicissimum} is under investigation as an alternative method for the recovery of lithium and cobalt from spent rechargeable Li-ion batteries. Bioleaching potential of these fungi was assessed by measuring biomass production to determine tolerance to three concentrations of lithium or cobalt. In order to examine tolerance, the three mold species were separately cultured under aerobic conditions in Czapek dox broth (CDB) for 5 days at 30°C. Samples were processed to determine dry weight biomass production, and pH of spent medium. Metal tolerance tests with lithium or cobalt were conducted in CDB while shaking at 120 rpm. Fungi were cultured with 0.1 mg/L, 3 mg/L, 100 mg/L and 1000 mg/L of lithium or cobalt for 5 days and samples were collected for dry weight biomass and pH measurements. Preliminary metal tolerance testing indicates that \textit{A. niger} can grow up to 100 mg/L of Li with little inhibition, and \textit{P. chrysogenum} was able to grow with 1000 mg/L of Li. \textit{P. simplicissimum} showed a significant decrease in biomass production with 100 mg/L of Li. All three mold species were significantly inhibited by 100 mg/L of Co. Due to the toxicity of lithium and cobalt, alternative strategies will be considered to select for metal tolerant fungi. These results will expand knowledge on metal tolerance for three mold species and will help identify a fungal species that can successfully recover lithium/cobalt from spent Li-ion batteries.
Sensor-Based Diagnostics of CNC Linear Axes

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Keywords: Computer Numerical Control (CNC), Inertial Measurement Unit (IMU)

Computer numerical control (CNC) machine tools are essential tools in the manufacturing of various components in the automotive and aircraft manufacturing industry. Thus, degradation of machine tool linear axes has a huge impact on the quality of parts manufactured through this process. Billions of US dollars are lost every year due to degradation of machine tools during production. Currently, there are direct methods of measuring geometric errors using laser-based and other standard methods. However, these methods are time-consuming and complicated for many users. In addition, such methods halt production, which usually equates to lost revenue, so manufacturers prefer not to shut down their machines for tests. Therefore, this project focuses on using an inertial measurement unit (IMU) with relatively inexpensive sensors for measuring changes in geometric errors of linear axes efficiently and with sufficient accuracy. The IMU-based method has been tested with much success on a linear axis testbed. Now, a smaller IMU is being set up for placement and practical usage on machine tools.

The linear axis testbed relies on acquiring axis position data from the motor encoder in the system. The main challenge was to derive nominal position data from an accelerometer rather than relying on other sources, so that the IMU can be placed in a “plug and play” fashion on any machine tool without needing to acquire controller position data. This process involved writing MATLAB functions that can derive position data from acceleration data from the accelerometers in the sensor box. Once a robust method was developed, the estimated positions were compared with the measured positions (from the testbed encoder) to determine the method accuracy. After the accuracy was determined to be sufficient for analysis purposes, the function was integrated into the main analysis code that estimates linear axis errors as a function of nominal axis position. Finally, metrics were tested for their ability to distinguish various level of degradation from the linear axis error motions. Future research involves creating a separate MATLAB-based GUI that uses the analysis subroutines for automatic detection of degradation, resulting in plots, metrics, and other aspects of a user-friendly GUI. In addition, the MATLAB-based GUI will use the estimated errors to visualize the error motions along a linear axis.
Dual-Arm Mobile Robot Platform for Assisting Individuals with Disabilities

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Keywords: Rehabilitation Robotics, Robot Arm, Mobile Robot, Wheelchair Mounted Robotic Arm (WMRA), printed circuit board (PCB)

This poster presents a robotic platform under development for use in rehabilitation robotics. This robotic platform, named MARA (MANUS Arm Robot Assistant), consists of two Manus Arms (commercial wheelchair mounted robotic arms (WMRAs) with 6 degrees of freedom each) mounted to a wheelchair base. The electrical system uses two control boxes, one for each MANUS arm, as well as a Galil motion control board for the wheelchair base. A printed circuit board was designed to simplify the wiring of the power distribution system, giving a central location for the buttons and relays for each component. This hardware design project serves as a precursor to low level software integration of the robot, where a Raspberry Pi will be used to control the system. The end goal for the MARA robot is to be used as an assistant mobile robot that can assist people with disabilities in their daily living activities.
Comparison of Simulated and Measured Fluid-Surface Oscillation Frequencies in a Channel

Matthew Trapuzzano\textsuperscript{1}, Kiesha Pierre\textsuperscript{1}, Emre Tufekcioglu\textsuperscript{2}, Rasim Guldiken\textsuperscript{2}, Andres Tejada-Martinez\textsuperscript{1}, Nathan Crane\textsuperscript{2}

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Keywords: Fluid-Surface Oscillation, Computational Fluid Dynamics, Wetting under Vibration

Many important processes from agriculture to manufacturing depend on the wetting of fluids on rough or textured surfaces. This has traditionally been studied from a macro-perspective. The effects of these surface features can be dramatically altered by vibrations that overcome energy barriers to contact line motion caused by surface roughness. In order to study these effects in confined geometries and at different length scales, a validated model is required. This presentation will compare the measured and simulated frequencies of capillary vibrations in a cylindrical glass tube. Fluid surface vibrations are excited externally through deformation of the interface. The resulting surface oscillations are observed with a high speed video camera and the dominant oscillation frequencies are calculated. The measured oscillation frequencies are compared to predictions from transient CFD simulations across a range of interface diameters from 400 um to 1.5 mm. These results may be used to inform studies of wetting under vibration.
Measuring Contrast Sensitivity of Rattus Norvegicus

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Keywords: Glaucoma, Vision Contrast Sensitivity, Mathematical Models

Glaucoma is an eye disease characterized by the loss of vision due to elevated intraocular pressure. There are currently no treatments that can completely cure glaucoma. Most treatments are designed to reduce intraocular eye pressure using eye drops, pills or surgery. These treatments are temporary solutions therefore need to be administered regularly, which could end up being a financial burden. Vision can be quantified in terms of contrast sensitivity functions; which are functions that describe the ability to detect features in an image due to differences in brightness. The contrast sensitivity varies depending on how detailed the image is. These contrast sensitivity functions can be used to quantify the effectiveness of novel treatments. To test the effectiveness of such treatments, one must set up a baseline to compare results. The goal is to model the contrast sensitivity functions of Norwegian brown rats and compare to human contrast sensitivity functions. Rats have been used in biomedical research due to their physiological similarities with humans. If humans and rats exhibit similar contrast sensitivity functions, treatments on rats can be tested and used to predict effectiveness on humans. Data was collected to measure the contrast sensitivity of the rats at different spatial frequencies, which were used to create contrast sensitivity functions. Analysis showed that the contrast sensitivity functions exhibit similar behavior as human contrast sensitivity functions, but at a different scale. Therefore, one can conclude that human and rat vision can be described using similar mathematical models, but with different parameters.
Preparation Methods for Fine 316 Stainless Steel Powder

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Keywords: Production Methods, Binder Jetting, Stainless Steel Powder, Agglomerates, Nylon

While Binder jetting produces relatively weak porous parts that are strengthened through sintering and/or infiltration, this paper reports on the two different methods of preparing fine 316 Stainless steel powder, and the impact of each method on the final sintered density relative to direct printing into -22 micron powder. The first method uses agglomerates of fine powder. In the second, nylon 12 powders are mixed with the steel powder as a fugitive space holder to increase porosity. Sintered density and sintering shrinkage of agglomerate material is shown to vary with the density of the spread powder bed. However, with added nylon the shrinkage correlates with the shrinkage of the base steel powder while the density depends on the quantity of the nylon. Thus, it is possible to create varied sintered density with compatible shrinkage levels—a key step towards creating binder-jetting systems with spatially controlled porosity.
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