Intelligent systems constellation

Vision:

The intelligent systems constellation will be the academic platform at Missouri S&T for fundamental and applied Artificial Intelligence research as applied to engineered systems, human interaction, and creative works (eg. Artificial Creativity). It will provide a communication and collaboration environment for constituent researchers across campus, including science, engineering, business, humanities, and social sciences.

Introduction:

There are many aspects to intelligent systems, but in the most general sense they are human-created systems that receive input from their environment and respond to that stimulus to achieve a beneficial response. This includes 'smart' devices, autonomous systems, and the myriad of other modern scientific tools and engineered systems people rely on to improve their lives and increase human capabilities. In addition to applications of AI, the research on the foundations of artificial intelligence, artificial creativity, and the social impacts of AI. The faculty in the intelligent systems constellation are affiliated with many national research centers, such as:

- The Center for Aerospace Manufacturing Technologies
- The NSF ERF for Future Renewable Electric Energy Delivery and Management Systems
- The NSF I/UCRC on Intelligent Maintenance Systems
- The DoD Systems Engineering Research Center UARC

Current capabilities and strengths:

The faculty affiliated with the intelligent systems constellation have established research programs currently underway in the following areas:

1. Smart living
    a. Sensory augmentation for mobility assistance
    b. Rehabilitation robotics
2. Smart manufacturing (overlap with manufacturing)
    a. Composite material additive manufacturing with AI control
    b. Nanostructured materials for extreme environments
    c. AI control of additive manufacturing for ceramics and metals
3. Smart infrastructure (overlap with infrastructure and transportation)
    a. Bridge inspection drones using computer vision
    b. Extreme event restoration prioritization modeling
    c. Cyber security of power generation and power consumers
    d. AI for microgrid stability
    e. Machine Learning for Signal/Power Integrity for High-speed systems
    f. Calculation of direct and indirect economic losses
    g. Dependability for Intelligent systems using stochastic models
4. Health care (overlap bio-x)
    a. Deep learning AI for kidney transplant networks

    b. Deep learning for fetal health prediction
    c. Machine learning in causal signaling networks for precision medicine
    d. Traumatic Brain injury (TBI)
5. Advanced/smart sensors
    a. Lab-in-a-fiber technology
    b. Integration of fiber optic sensors for structural health monitoring
6. Energy storage and conversion
    a. High energy density capacitors
    b. AI for Smart batteries
7. Global Internet
    a. Digital inclusion (information system available to a wider population)
    b. 5G for AI
    c. Machine learning for Internet of Things security
8. Economics
    a. Computational Intelligence for volatility and price forecasting
    b. AI for intelligent portfolio management
9. Autonomous Systems
    a. Control of connected and autonomous vehicles
    b. Agent based autonomous control and situational awareness
    c. Mobile Data Security and Management
    d. Deep learning adversary for operations training
    e. Navigation and control of multi-agent autonomous systems
10. Artificial Creativity
    a. Augmented, virtual and mixed reality
    b. Design thinking and AI
    c. Artificial Intelligence for Music

Research Opportunities and growth areas for AI and intelligent systems

- There is a concerted effort within the federal government to move artificial intelligence research forward. A report by a group of AI subcommittees of the National Science and Technology Council laid out eight strategies for AI R&D. This group was comprised of members representing leadership in twenty different government agencies, including NIH, NSF, NIST, DARPA, DOT, NOAA, and all branches of the U.S. Military. These strategies are:
    - Make long-term investments in AI research
    - Develop effective methods for human-AI collaboration
    - Understand and address the ethical, legal, and societal implications of AI
    - Ensure the safety and security of AI systems
    - Develop shared public datasets and environments for AI training and testing
    - Measure and evaluate AI technologies through benchmarks and standards
    - Better understand the national AI R&D workforce needs
    - Expand public-private partnerships in AI to accelerate advances in AI

Each of these strategies can be mapped directly into one or more current research efforts underway by members of this constellation.

- DARPA Artificial Intelligence Exploration Grants - DARPA has a current campaign to develop the next wave of AI technology. The focus is to create computers with the capability to be partners in problem-solving rather than specialized tools for only particular applications. This is a multi-year effort that will help drive AI for the defense sector.
- National Science Foundation – Researchers affiliated with the Intelligent Systems Center have a long record of support in smart systems research from the NSF. There are several focus areas within the NSF working on AI in eleven different programs, including those our faculty members have established records of research within intelligent systems, such as:
    - Civil, Mechanical, and Manufacturing Innovation
    - Cyber-Physical Systems
    - Electrical Communications and Cyber Systems programs

  There are additional funding opportunities such as AI and Society (with Partnership on AI), Fairness in Artificial Intelligence (with Amazon), and Real-Time Machine Learning (with DARPA).
- Department of Energy – The U.S. Department of Energy has created a new Artificial Intelligence and Technology Office to "Transform the Department of Energy into the United States Government's lead agency in the civilian use of artificial intelligence by accelerating the research, development, delivery, and application of AI."
- Industry - When considering funding sources from industry, the pursuit of additional Industry-University cooperative Research Centers would strengthen our capabilities. Currently, Missouri S&T has an IUCRC for electromagnetic compatibility (Beetner, Madria, Sarangappani, et al), resulting in quick partnering for research opportunities, specialty research for the industry partner, and an overall better understanding of the current industry needs. Approaching other industries to establish these agreements would also prove beneficial. Potential industry partners faculty are already working with include:

    - The Boeing Company
    - Monsanto
    - Garmin
    - Honeywell
    - Ford
    - GM

The formation of an IUCRC with automotive companies could be assisted by leveraging a proposed mobility consortium. This consortium can also make inroads to research agreements with agriculture equipment manufacturers, with an added benefit of our research showing direct impact for the citizens of Missouri.

The challenge to take advantage of these opportunities is to connect to these agencies, understand their needs, and leverage our existing research and expertise to convince them that Missouri S&T is where this research should be done.

Associated Campus Labs and Centers

1. Intelligent Systems Center – The Intelligent Systems Center is a direct overlap with this constellation. All members of this constellation are also members of the Intelligent Systems Center, and a common mission statement is shared between them.
2. Laboratory for Information Technology Evaluation (LITE).
    - Skills/AI applications: Human-computer interaction - controlled and field experiments involving human subjects as well as surveys and case studies.
    - Lab capabilities: Eye-tracking and EEG devices
    - Campus collaborators: Fiona Nah, Guirong (Grace) Yan, Nancy Stone, Ting Shen, Matt Thimgan, Langtao Chen, and Mike Hilgers
3. Virtual and Augmented Systems Engineering Laboratory (VASEL).
    - Skills/AI applications: Virtual and Augmented Reality – human interactions with virtual environments and actors.
    - Lab capabilities: 15K+ graphics core processing for AI, HMD VR/AR devices, haptic feedback, omni directional treadmill.
    - Campus collaborators: Benjamin Kwasa, Steven Corns, Suzanna Long, Donald Wunsch, Genda Chen, Philip Mulligan
4. Shared Psychological Science Laboratory.
    - Skills/AI applications: Human perceptions of technology (including AI).
    - Lab capabilities: Workstations and interview areas
    - Campus collaborators: Daniel Shank, Donald Wunsch, David Wright, Casey Canfield, Cihan Dagli, Patrick Gamez, Sarah Hercula
5. Physical Human-Robot Interaction Laboratory.
    - Skills/AI applications: Biomechanics of effective and intuitive physical interaction between humans and robots.
    - Lab capabilities: Workstations and interview areas
    - Campus collaborators: Yun Seong Song, Devin Burns

Detailed charts describing other labs follow, along with member quad charts in the appendix.

Applied Computational Intelligence Laboratory

Mechanisms and Applications of Unsupervised Learning

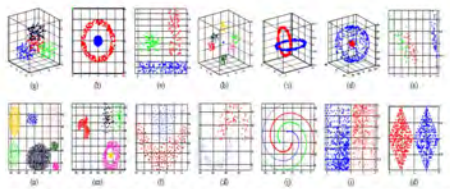
- Information theoretic and growing regions clustering
- Collaborative Filtering
- Data Mining, Parallelization
- Infrared Image Analysis
- Mixed Modality Learning for Lifelong Learning Machines

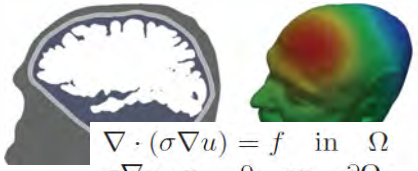
Reinforcement Learning in Autonomous Systems

- Autonomous vehicles and robot swarms
- Human interactions with intelligent systems
- Trust and explainability in AI
- Robust nonlinear controls under uncertainty and delay

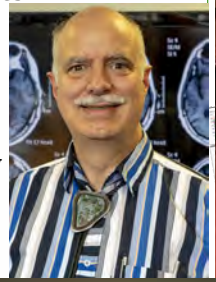
Brain Science and Mental Health

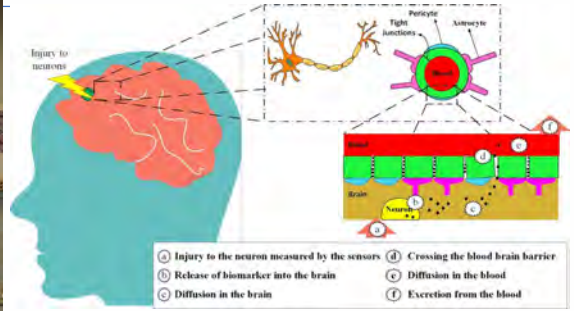
- Traumatic Brain Injury
- Autism gene expression and functionality studies
- Data analytics of sleep vs. task performance





$$\nabla \cdot (\sigma \nabla u) = f \quad \text{in} \quad \Omega$$
$$\sigma \nabla u \cdot \mathbf{n} = 0 \quad \text{on} \quad \partial\Omega$$





PoC: Donald C. Wunsch II, Ph.D., MBA
Mary K. Finley Missouri Distinguished Prof.
dwunsch@mst.edu
573-341-4521

Funding

- DARPA
- Dept. of Education
- Army Night Vision Labs
- Leonard Wood Institute

MISSOURI S&T
www.mst.edu

1. Necessary tool for online (streaming) learning
2. Mitigating order-dependence in online or batch learning
3. Model Order Reduction w Clustering

ACIL

Journal papers:

2019 - 21
2020 - 10
So far

IEEE Access

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Digital Object Identifier 10.1109/ACCESS.2020.2969849

Incremental Cluster Validity Indices for Online Learning of Hard Partitions: Extensions and Comparative Study

1

LEONARDO ENZO BRITO DA SILVA[1,2], (Member, IEEE), NIKLAS MAX MELTON[1], (Member, IEEE), AND DONALD C. WUNSCH II[1], (Fellow, IEEE)

[1] Applied Computational Intelligence Laboratory, Missouri University of Science and Technology, Rolla, MO 65409, USA

Cluster validity index (CVI)	Formulation[a]	Reference(s)
Calinski-Harabasz[b]	$CH = \frac{\left(\sum_{i=1}^{k} n_i \|\boldsymbol{v}_i - \boldsymbol{\mu}_{data}\|_2^2\right)/(k-1)}{\left[\sum_{i=1}^{k} CP_2^2(\boldsymbol{v}_i, \omega_i)\right]/(N-k)}$	[28]
WB-Index[b]	$WB = k\frac{\sum_{i=1}^{k} CP_2^2(\boldsymbol{v}_i, \omega_i)}{\sum_{i=1}^{k} n_i \|\boldsymbol{v}_i - \boldsymbol{\mu}_{data}\|_2^2}$	[21], [29]
Davies-Bouldin[b]	$DB = \frac{1}{k}\sum_{i=1}^{k} \max_{i \neq j}\left(\frac{\left[\frac{1}{n_i} CP_q^q(\boldsymbol{v}_i, \omega_i)\right]^{\frac{1}{q}} + \left[\frac{1}{n_j} CP_q^q(\boldsymbol{v}_j, \omega_j)\right]^{\frac{1}{q}}}{\left[\sum_{t=1}^{d} \|v_{it} - v_{jt}\|^p\right]^{\frac{1}{p}}}\right)$	[22]
Xie-Beni[b]	$XB = \frac{\sum_{i=1}^{k} CP_2^2(\boldsymbol{v}_i, \omega_i)/N}{\min_{i \neq j} \|\boldsymbol{v}_i - \boldsymbol{v}_j\|_2^2}$	[23]
Generalized Dunn's index 43[b]	$GD_{43} = \frac{\min_{i \neq j} \|\boldsymbol{v}_i - \boldsymbol{v}_j\|_2}{\max_k \left[\frac{2CP_2^1(\boldsymbol{v}_k, \omega_k)}{n_k}\right]}$	[24], [25]
Generalized Dunn's index 53[b]	$GD_{53} = \frac{\min_{i \neq j} \left[\frac{CP_2^1(\boldsymbol{v}_i, \omega_i) + CP_2^1(\boldsymbol{v}_j, \omega_j)}{n_i + n_j}\right]}{\max_k \left[\frac{2CP_2^1(\boldsymbol{v}_k, \omega_k)}{n_k}\right]}$	[24], [25]
PBM Index[b]	$PBM = \left[\frac{\frac{1}{k}\sum_{i=1}^{k} \|\boldsymbol{x}_i - \boldsymbol{\mu}_{data}\|_2}{\sum_{i=1}^{k} CP_2^1(\boldsymbol{v}_i, \omega_i)} \max_{i \neq j} (\|\boldsymbol{v}_i - \boldsymbol{v}_j\|_2)\right]^2$	[30], [48]
Silhouette[b]	$SIL = \frac{1}{N}\sum_{i=1}^{N} \left\{\frac{\min_{i \neq j}\left[\frac{1}{n_i} CP_2^1(\boldsymbol{x}_i, \omega_i)\right] - \frac{1}{n_i} CP_2^1(\boldsymbol{x}_i, \omega_i)}{\max\left(\frac{1}{n_i} CP_2^1(\boldsymbol{x}_i, \omega_i), \min_{i \neq j}\left[\frac{1}{n_j} CP_2^1(\boldsymbol{x}_i, \omega_j)\right]\right)}\right\}$	[31]
Partition Separation	$PS = \sum_{i=1}^{k}\left\{\frac{n_i}{\max_j(n_j)} \cdot exp\left[-\frac{\min_{i \neq j}(\|\boldsymbol{v}_i - \boldsymbol{v}_j\|_2^2)}{\frac{1}{k}\sum_{i=1}^{k} \|\boldsymbol{v}_i - \frac{1}{k}\sum_{i=1}^{k} \boldsymbol{v}_i\|_2^2}\right]\right\}$	[54], [55]
Negentropy Increment[c]	$NI = \frac{1}{2}\sum_{i=1}^{k} p_i \ln \\|\boldsymbol{\Sigma}_i\\| - \frac{1}{2}\ln \\|\boldsymbol{\Sigma}_{data}\\| - \sum_{i=1}^{k} p_i \ln p_i$	[32], [33]
Representative Cross Information Potential[c]	$CEF = \sum_{i=1}^{k}\sum_{j=i+1}^{k}\left[\frac{1}{M_i M_j}\sum_{l=1}^{M_i}\sum_{m=1}^{M_j} \frac{e^{-\frac{1}{2}(\boldsymbol{v}_l - \boldsymbol{v}_m)^T(\boldsymbol{\Sigma}_l + \boldsymbol{\Sigma}_m)^{-1}(\boldsymbol{v}_l - \boldsymbol{v}_m)}}{\sqrt{(2\pi)^d \\|\boldsymbol{\Sigma}_l + \boldsymbol{\Sigma}_m\\|}}\right]$	[34], [35]
Conn_Index[d]	$Conn\_Index = \left(\frac{1}{k}\sum_{l=1}^{k} \boldsymbol{Intra}(\omega_l)\right)\left(1 - \frac{1}{k}\sum_{l=1}^{k} \max_{m, m \neq l} [\boldsymbol{Inter}(\omega_l, \omega_m)]\right)$	[37], [38]

[a] $\boldsymbol{x}_i$ represents the ith sample of a data set $\boldsymbol{X}$, k represents the number of clusters, N represents the data set cardinality, n_i represents the number of samples in cluster ω_i, $\boldsymbol{v}_i$ represents a prototype of cluster ω_i (computed using Eq. (1)), and $\boldsymbol{\mu}_{data}$ represents the data mean (computed using Eq. (2)).

IEEE TRANSACTIONS ON NEURAL NETWORKS AND LEARNING SYSTEMS, VOL. 30, NO. 6, JUNE 2019

Model Order Reduction Based on Agglomerative Hierarchical Clustering

3

Sezar Al-Dabooni, *Member, IEEE*, and Donald Wunsch, *Fellow, IEEE*

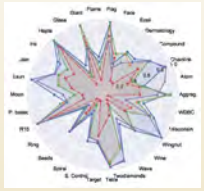
Contents lists available at ScienceDirect

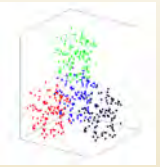
Neural Networks

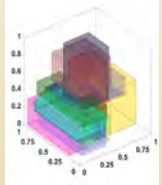
journal homepage: www.elsevier.com/locate/neunet

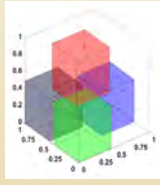
Distributed dual vigilance fuzzy adaptive resonance theory learns online, retrieves arbitrarily-shaped clusters, and mitigates order dependence

Leonardo Enzo Brito da Silva [a,*], Islam Elnabarawy [b], Donald C. Wunsch II [a]



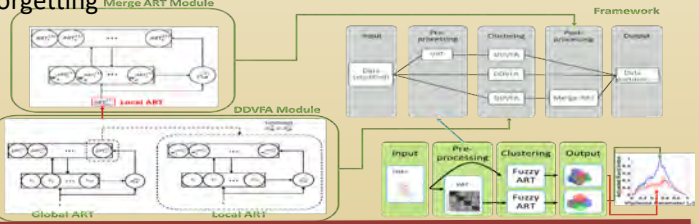


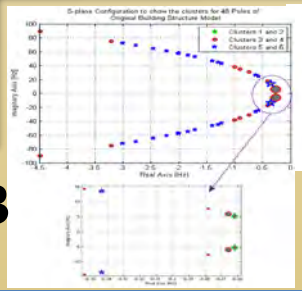


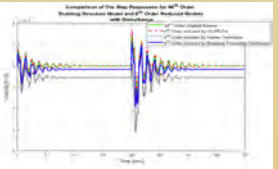


- Multi-prototype (unsupervised many-to-one map)
- Dual vigilance: global and local fuzzy ART modules
- Higher order distributed activation
- Able to retrieve arbitrarily shaped clusters
- **Incremental: performs like others' batch**
- Avoids catastrophic forgetting

2







2019 Books

DARPA

Yue-Wern Huang – Facility and Skill Set

Confocal microscope (s)
- Track fluorescent molecules in single cells

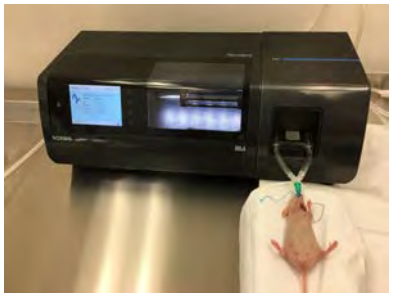
Cell culture
- *In vitro* experiments
- Various cell lines

Cytospin:
- Separate blood components

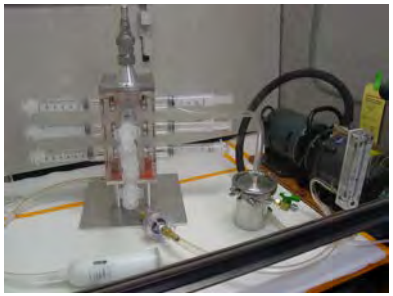
Whole-body inhalation chamber (s)

Flow cytometer (s)
- Track fluorescent molecules in single cells

Vivarium (s):
- *In vivo* experiments
- Transgenic or regular rats and mice



Flexi-Vent
- Measure lung functions and mechanic



Nose-only inhalation chamber
- Expose mice to air pollution or particulate matters

PoC
- Yue-Wern Huang, Professor; E-Mail: huangy@mst.edu
- Website: http://web.mst.edu/~huangy/; 573-341-6589

Skill set:
- Cell culture studies; whole animal studies; tissue regeneration; drug delivery; toxicology; stressors on human and environmental health

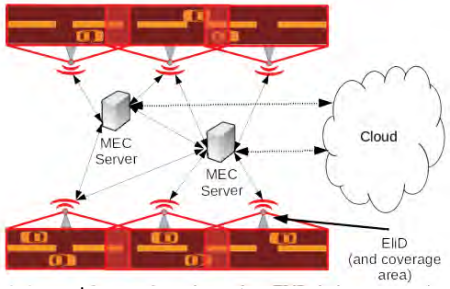
(s=shared)

Resource Managements in Wireless Networks

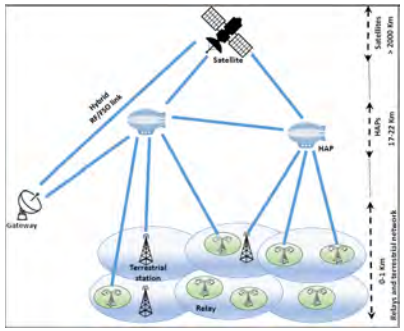
Digital inclusion:
How to make sure the interacting with information system is accessible to much wider population size.

Safety and security:
Including integrity and confidentiality.

Improved efficiency:
Main driver of the communication and network systems.



Edge Computing – Elevated LiDAR



Global Connectivity

Visible Light Communications

Ahmad Alsharoa
Assistant Professor
Electrical and Computer Engineering
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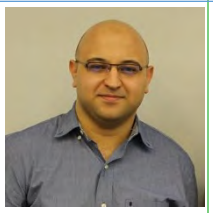


BS Electrical Eng., Jordan University of Science & Technology.
MS Electrical Eng., King Abdullah University of Science & Technology.
PhD Electrical & Computer Eng., Iowa State University.

Keywords
- wireless networks, Optimization, Optical wireless networks, Aerial communications, Internet of things, Green wireless, energy harvesting, Edge computing, Cooperative relay networks, Self healing, MIMO communications.

Recognitions
- Senior IEEE member.
- Preeminent Postdoctoral Program (P3) Award, UCF.
- GPSS Research Award, ISU.
- Research Excellence Award, ISU.
- Outstanding International Award, ISU.

DEPARTMENT OF PSYCHOLOGICAL SCIENCE

Cognitive neuroscience and psychology of music

Some Current Projects:

Autobiographical Memory

- Which memory cues (music or others) are most effective in healthy aging and Alzheimer's disease?

Emotion, Preference, and Choice

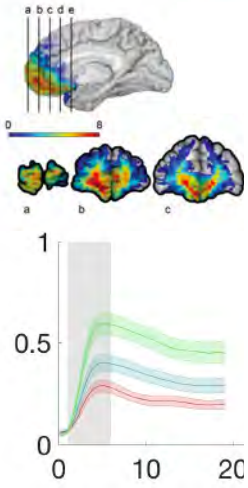
- How do individuals make aesthetic choices over time ("Why do we like what we like?")
- What are the characteristics of selective musical anhedonia, and does this change across the lifespan?

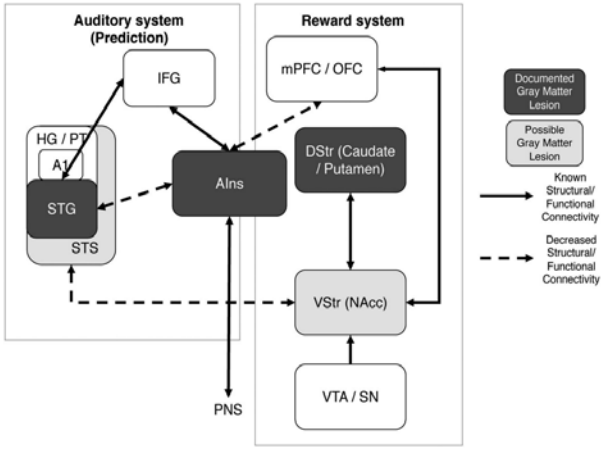
Conceptual Representations

- What are the neural correlates of lexical and conceptual retrieval for semantically unique items (e.g., songs, faces)?

Methods

- Behavior, neuropsychology, psychophysiology (ECG, EDA), fMRI





Neuropsychological studies of patients with focal brain damage (Belfi et al., 2018); continuous ratings of aesthetic preferences (Belfi et al., 2019); neuroanatomical model of musical anhedonia (Belfi & Loui, 2020)

Contact Information:

Amy M. Belfi,
Assistant Professor,
Psychological Science
amybelfi@mst.edu

PhD, Neuroscience,
University of Iowa
https://www.amybelfi.com

Keywords

- Cognitive psychology, neuroscience, neuropsychology, music, memory, emotion, language, preferences, aging

Potential Collaboration fields

- Cognitive neuroscience, auditory perception, neurological disorders, memory, emotion, language, decision-making

Google Scholar Profile

Power System and Electricity Market Operation and Optimization

Large-scale Power System Optimization and Computation

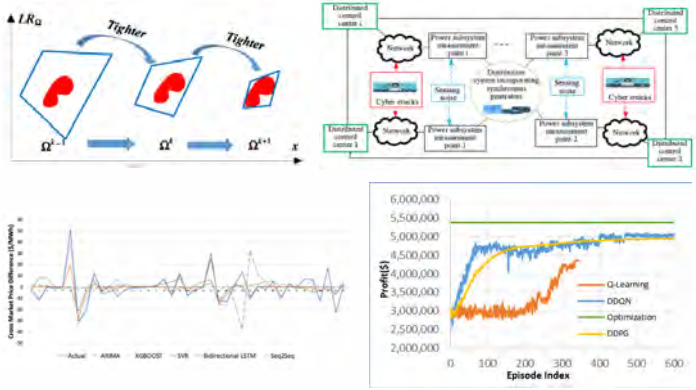
- Power system operation and planning under uncertainty
- Grid integration of renewables, electric vehicles and energy storage
- GPU-based parallel computing and high performance computing
- Network equivalence

Electricity Market Modeling, Monitoring and Simulation

- Testbed of complex markets modeling
- Optimization and reinforcement-learning based bidding strategy development
- Market design and evaluation
- Energy and price forecasting
- Emerging technology and energy policy evaluation

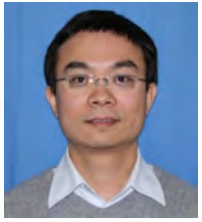
Cyber Physical System Security of Power Systems and Electricity Markets

- State estimation of networked systems
- False data injection attacks and counter measures
- System vulnerability and enhancement



Optimization, State Estimation, Energy Forecasting, Reinforcement Learning

PoC: Rui Bo
Assistant Professor
rbo@mst.edu
573-341-6400



Funding

- DARPA; NSF
- Department of Energy
- DOD ESTCP
- Industry

Keywords

- Grid, optimization, uncertainty, parallel computing, reinforcement learning, cyber security, energy forecasting, state estimation

Recognitions

- University of Missouri System President's Award for Career Excellence - Early Career, 2020
- Faculty External Recognition Award, Missouri S&T, 2019
- DARPA Young Faculty Award, 2018

DEPARTMENT OF MECHANICAL AND AEROSPACE ENGINEERING

Precision Control of Advanced Manufacturing Systems

Layer-to-layer sensing and control in additive manufacturing

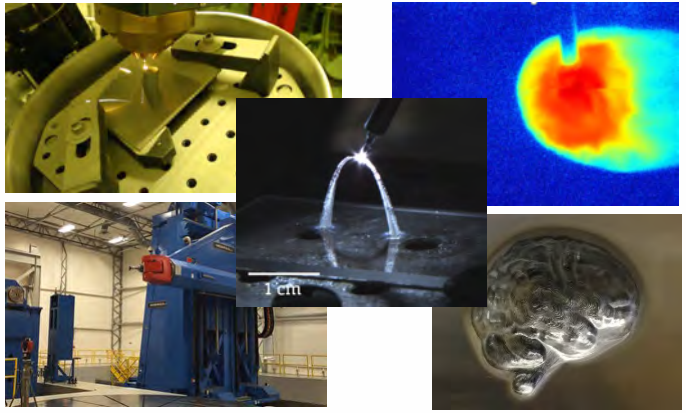
- Spatial dynamic framework for high bandwidth, precision control of geometry and thermal dynamics
- Demonstrated in powder and wire DED, laser PBF.

Metrology in-the-loop control of robotic machining

- Kinematic error observer framework for real-time correction of robotic motion using integrated 6D laser tracker sensor.
- High bandwidth, active vibration isolation robotic machining head.

Dual-probe atomic force microscopy (AFM)

- Simultaneous manipulation and sensing in a shared nano-workspace.
- Closed-loop precision manipulation demonstrated in plowing.



Advanced control solutions developed for precision process control across an array of manufacturing systems.

PoC: Douglas A. Bristow
Professor of Mechanical Engineering
Director, Center for Aerospace Manufacturing Technologies
dbristow@mst.edu, camt.mst.edu

Funding

- NSF, LANL, ORNL, KCNSC, America Makes, MxD, Boeing, GKN Aerospace, Caterpillar, Toyota, LMI Aerospace, Swarovski, Automated Precision, Castrip

Keywords

- additive manufacturing, robotics, advanced manufacturing, precision control systems

Center for Aerospace Manufacturing Technologies

DEPARTMENT OF ENGINEERING MANAGEMENT AND SYSTEMS ENGINEERING

Decision Science for Infrastructure Systems

Test Human Decision-Making Interventions

- Design and assess randomized control trials to test human-computer interfaces, risk communications, and trainings in the lab and field
- E.g. AI interface for **kidney transplant process**

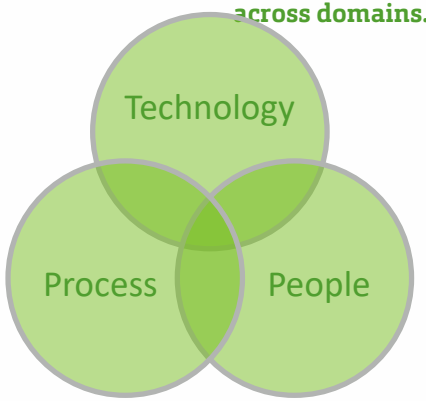
Describe Program Impacts

- Use quasi-experimental techniques to evaluate the impact of government and industry programs
- E.g. SolSmart national designation program evaluation

Model and Simulate Socio-technical Systems

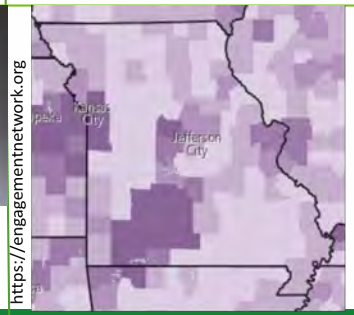
- Perform risk, benefit-cost, uncertainty, sensitivity analysis
- Predict impacts of behavioral interventions on system
- E.g. **Rural broadband adoption simulation**

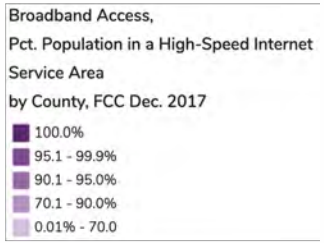
Use Decision Science to develop human-centered approaches for big data and autonomous systems across domains.



PoC: Casey Canfield, PhD
Assistant Professor,
Engineering Management & Systems Eng.
canfieldci@mst.edu;
https://www.caseycanfield.com/
PhD Engineering & Public Policy,
Carnegie Mellon University

Funding: National Science Foundation, Sloan Foundation, The Solar Foundation, Missouri Department of Transportation





Composite Materials and Structures

Composite materials and structures

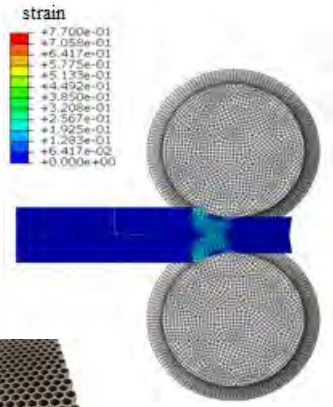
- Fiber reinforced polymer composite for aerospace structures
- Multifunctional composites for specific applications such as transparent composites and smart structures
- Reinforced ceramics for high temperature applications
- Bio-based composites for structural applications

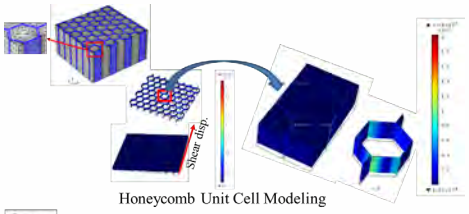
Polymer and metal additive manufacturing

- Composite tooling using additive manufacturing of polymers
- Manufacturing and testing of metallic cellular structures
- Numerical homogenization and unit-cell modeling

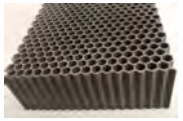
Modeling and finite element simulation

- Modeling of steel hot-rolling process
- Modeling of oxidation induced degradation and ceramic composites using unit cell modeling
- Process modeling of composite fabrication



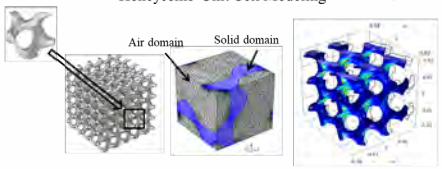


Honeycomb Unit Cell Modeling



Honeycomb

Octet-truss



Gyroid Unit Cell Modeling

Multiple Unit Cells

Gyroid

PoC: K. Chandrashekhara,
Curators' Distinguished Professor,
Mechanical and Aerospace Engineering
chandra@mst.edu;
http://web.mst.edu/~chandra/

Recent Funding

National Science Foundation, Office of Naval Research, Naval Air Systems Command, Army/Benet Labs, Boeing, Nucor, Gerdau, GKN Aerospace,Honeywell, Spirit AeroSystems, United Soybean Board, Leonard Wood Institute.

Keywords

- #CompositeMaterials, #FiniteElementAnalysis, #CellularStructures, #Bio-Composites, #AdditiveManufacturing

Recognitions

Fellow: ASME

Society of Military Engineers Award (2008)

American Foundry Society- Best Paper Award (2013)

SAMPE Journal Feature Article (2016)

New Wireless Technologies For Next-Generation IoTs

Internet-of-Multimedia Things

- Compressed sensing based multi-view coding and decoding architecture design
- Power-efficient wirelessly multi-view video streaming

Wireless Visible Light Networking

- Alleviate RF spectrum crunch
- Newly-designed visible-light-channel aware protocol stack

Intelligent Wireless Systems

- Learning based optimized network operations
- Software-defined experimental prototype

Internet of Things is making our lives more efficient and easier!

PoC: **Nan Cen**, Ph.D.,
Assistant Professor
Computer Science Department
nancen@mst.edu,
https://sites.google.com/a/mst.edu/nancen/home

Keywords

- #Internet-of-Things, #Wireless Visible-Light Networks, #Compressed Sensing, #Low-power, #Low-complexity, #intelligent Wireless Systems, #Learning Techniques

Recognitions

- Award: 2019 ECE Distinguished Research Assistant Award
- Award: 2018 CRA-W and ComSoc Travel Grant
- Award: 2015 NSF Student Travel Grant
- Award: 2015 N2Women Young Research Fellowship

ENGINEERING MANAGEMENT AND SYSTEMS ENGINEERING DEPARTMENT

Computational Intelligence in Complex Systems

Computational Intelligence (Evolutionary Computation)

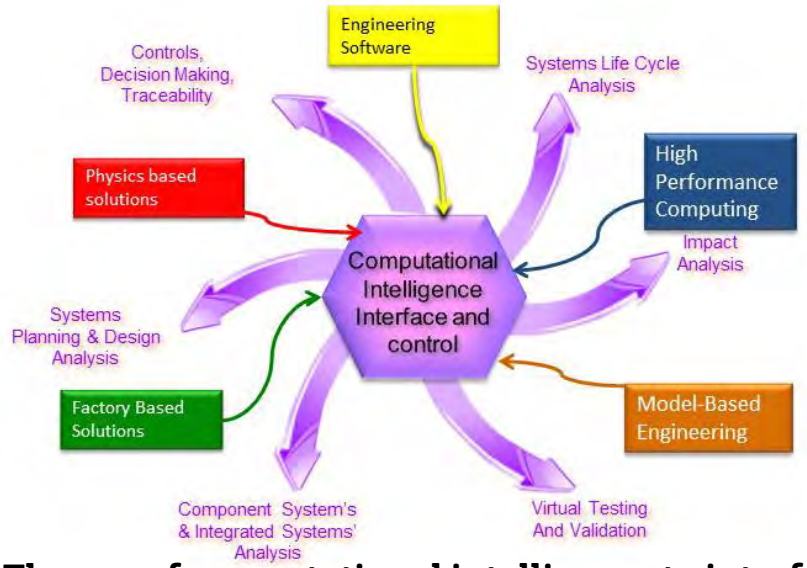
- Evolutionary computation theory and applications
- Artificial life, agent-based modeling, numerical optimization

Autonomous Systems

- Agent Based autonomous control
- Computational intelligence for situational awareness
- Hybrid algorithms for decision making

Complex System Modeling

- Combine disparate models and simulations to represent system as a whole
- Increase confidence in technical performance and reduce risk before system is created



The use of computational intelligence to interface and optimize complex systems

PoC: Steven Corns, Associate Chair for Graduate Studies, Engineering Management and Systems Engineering Department
cornss@mst.edu; http://mst.edu/~cornss

Funding

- United States Army Corps of Engineers, United States Geological Survey, Federal Manufacturing and Technologies (Honeywell), Department of Veterans' Affairs, The Boeing Company, Missouri Department of Transportation

Keywords

- #Computational Intelligence, #Complex Systems, #Evolutionary Computation, #Model-Based Systems Engineering, #Bioinformatics

Recognitions

- IEEE Computational Intelligence
  - Evolutionary Computation Technical Committee
  - Chair of Bioinformatics and Bioengineering TC
- INCOSE Model-Based Systems Engineering Leadership team
- ASEM Fellow

DEPARTMENT OF ENGINEERING MANAGEMENT AND SYSTEMS ENGINEERING

Cihan H Dagli, Founder and Director of Systems Engineering Graduate Program Professor of Engineering Management and Systems Engineering and Affiliated Professor of Electrical and Computer Engineering

Summary

Dr. Dagli joined Missouri S&T in 1988. His research interests are in systems engineering and systems architecting, cyber physical systems, deep learning, machine learning and computational intelligence. Dr. Dagli has been a PI, co-PI, or director of 56 research projects and grants totaling over $25 million from federal, state, industrial funding agencies, and distance tuition revenue. Approximately more than $21 million of this total has been generated through the Systems Engineering Graduate Program during his tenure as program director (2000-Present). This number does not include a $10 million grant from the Department of Defense that was approved in September 2008 for the establishment of the Systems Engineering Research Center - University Affiliated Research Center (UARC) at Steven's Institute of Technology with the aid of ***Missouri S&T, the University of Southern California, the Massachusetts Institute of Technology***, and other participating universities.

Dr. Dagli has published over 450 research publications, including 79 archival journal articles and edited (or co-edited) 34 books. His research publications have been cited on Google Scholar 4,449 times, with an h-index of 31 and i-index of 118 . He was the dissertation advisor of 26 Engineering Management one Computer Science and 9 Systems Engineering PhD students received their degree from S&T.

Systems Engineering , Cyber Physical Systems and Deep Learning

Dr. Dagli's contributions to systems engineering began in 1979 with his PhD dissertation at The University of Birmingham, Birmingham, England, titled "A Methodology for Solving the Long Term Operational Problems of the Lower Firat Basin in Turkey". His 1980 paper titled "Determining operating policies for a water resource system", CH Dagli, JF Miles Journal of Hydrology 47 (3), 297-306 is still being cited in 2020. This interdisciplinary topic lead to a mathematical programming model based approach for the solution of this complex water resources system problem. In the intervening years, he continued work on large scale, system based problems. He has expertise in modeling architectures for complex engineering systems such as transportation, infrastructure, water resources, and energy distribution using computational intelligence techniques.

Systems Engineering, Cyber Physical Systems and Deep Learning (cont.)

After becoming a Senior Investigator on Systems Architecting at the DoD Systems Engineering Research Center-UARC, Dr. Dagli focused on Cyber Physical Systems and System of Systems research and worked as a PI on numerous DoD research projects. He also founded and chaired annually the Complex Adaptive Systems conferences since 2011. Complex Adaptive System 2021 conference will be virtual and held on June 16-18, 2021. He was able to develop an integrated model based on computational intelligence and systems architecting for architecting system of systems and cyber physical systems. The general description of the integrated model structure with examples is provided in the following reference: Flexible and Intelligent Learning Architectures for SoS (FILA-SoS) Volume 1 – Integrated Model Structure Cihan H. Dagli, et. al.. Technical Report SERC-2015-TR-021-4_V1.

Dr. Dagli is the leading U.S. research expert in smart system architecting, data analytics, and machine learning in response to complex system autonomy and adaptation. His current research involves self-organizing meta-architectures using deep learning neural networks to create adaptive behavior. This work builds on the Flexible Intelligent Learning Architectures for System of Systems (FILA-SoS). He is one of only 72 INCOSE Fellows in the world and a former chair of fellows (2010-2014). Dr. Dagli was nominated to Systems Engineering Honor Society, Omega Alpha Association in 2013 and became Chairman of the Board in July 2016.

Computational Intelligence and Machine Learning

Dr. Dagli was one of the leaders in Artificial Neural Network research and teaching on campus since 1989. He was the founder and organizer 20 ANNIE conferences Artificial Neural Networks in Engineering. Dr. Dagli was able to bring new insights to several industrial engineering research problems, such as Group Technology (GT), Scheduling, and Stock Cutting through the use of computational intelligence techniques. He became an Institute of Industrial and Systems Engineering (ISIE) Fellow on May 31, 2009. He was also able to combine his expertise in systems engineering with manufacturing by bringing the International Conference on Production Research ICPR 25 with a theme Cyber Physical Manufacturing to Chicago to be held on August 10-15, 2019. This is the third time this international conference isheld in USA since its inception in 1971.

MISSOURI S&T

DEPARTMENT OF COMPUTER SCIENCE

Smart Living: The Next Frontier (Sajal K. Das, CS)

Smart Environments / Cyber-Physical-Human Systems

- **(Smart Healthcare)** Monitor activities of daily living through sensors, wearable, and smart chair for wellness management and early detection of cognitive impairment.
- **(Smart Grid)** Characterize complex dependency between communication networks and electrical grid to optimize energy consumption and control cascade failures.
- **(Disaster Response)** Establish post-disaster communication network infrastructures.

Wireless Sensor Networks (WSN) / Internet of Things (IoT)

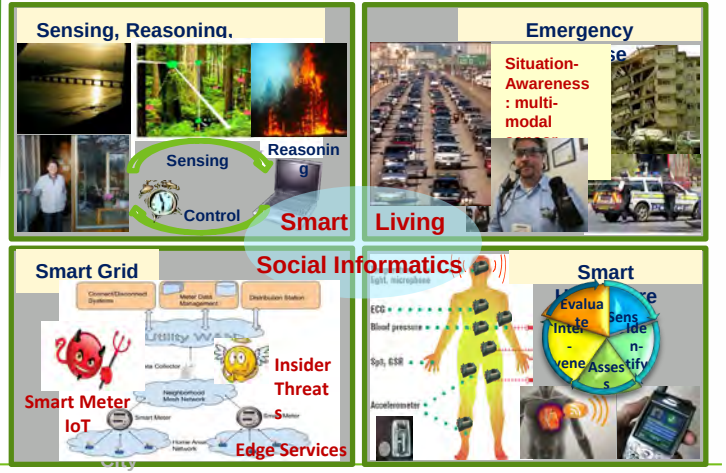
- Design energy-efficient architectures, algorithms and protocols for multi-modal data collection, fusion, coverage, and routing with novel applications in WSNs and IoT.

Cyber-Physical Security

- Provide high information assurance, security, reliability, and trustworthiness in CPS with human ~~in the loop~~.

Mobile and Pervasive Computing

- Develop context/situation aware models in ubiquitous computing systems in the presence of uncertainty due to mobility, topology dynamics, and resource availability.



PoC: Sajal K. Das, Professor and Chair
Department of Computer Science
Daniel St. Clair Endowed Chair
sdas@mst.edu

Funding

- NSF, AFOSR,, Department of Justice, NASA, Industry

Keywords

- #Smart Living, #Cyber-Physical Systems, #Wireless Sensor Networks, #Pervasive Computing, #Big Data, #Cloud Computing, # Cyber-Security, #Social Informatics

Awards/ Recognitions

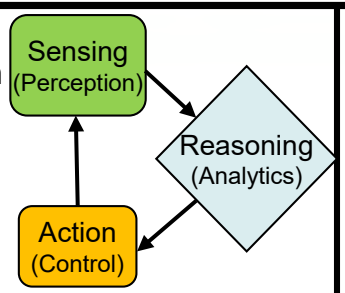
- IEEE Fellow.
- IEEE Computer Society Technical Achievement Award.
- UM System President's Award for Sustained Career Excellence
- Ten Best Paper Awards in IEEE and ACM Conferences.
- Editor-in-Chief, Associate Editor of various journal.

Securing Cyber-Physical Systems (CPS)

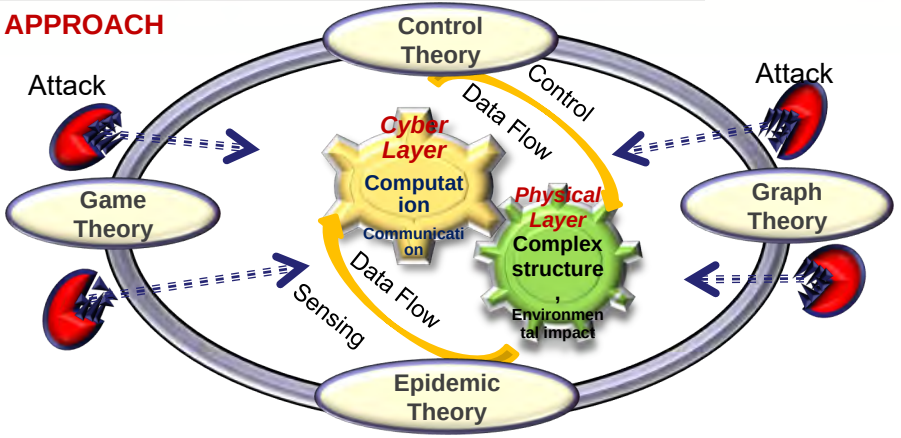
Sajal K. Das, Computer Science, sdas@mst.edu

OBJECTIVES

- Design dependable and secure CPS with human in the loop.
- Improve performance and system reliability
- Adapt to uncertainty and impacts – failures, attacks, disasters – to prevent cascade failures.



APPROACH



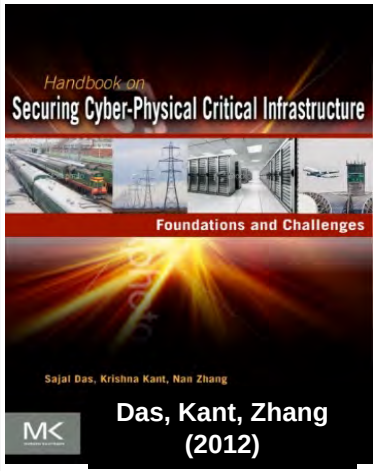
RESULTS

- Five NSF grants as PI on CPS security.
- Publications in top-tier journals and

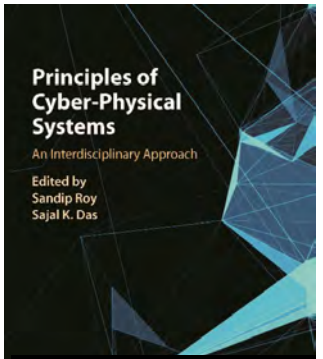
POTENTIAL IMPACT

- Situation-aware threat monitoring, analysis and recovery from failures, attacks, and disasters.
- Multi-level CPS Security framework for higher information assurance.
- Characterization of inter- dependency across CPS.

Situation- Awareness: Humans as sensors feed multi-modal data streams



Das, Kant, Zhang (2012)



Cambridge University Press (2020)

Materials Science and Technology

Solid Oxide Fuel Cells and Lead Batteries

- Processing and electrochemical characterization of solid oxide fuel cells and lead-acid batteries, development of nanostructured cathode and anode materials

High Temperature Superconductors

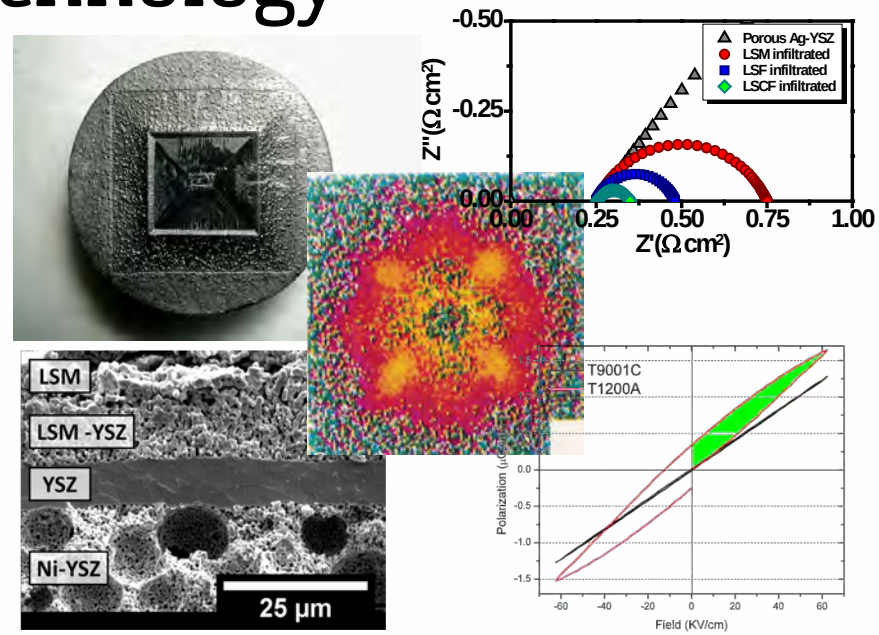
- Crystal growth of high temperature superconductors for magnetic flux trap applications, neutron scattering studies to understand electronic structure and mechanism of high T_c superconductivity

High Energy Density Capacitors

- Nanostructured dielectric materials as high energy density multilayer ceramic capacitors for pulse power applications

Nanostructured Composite Materials

- Developing ceramic nano particle and polymer composites for high energy density of capacitor and helmet liners to mitigate traumatic brain injury (TBI); characterization of composites by impedance spectroscopy techniques



Understand microstructure and property relationships to process materials of superior performance

PoC: Fatih Dogan, Professor,
Materials Science and Engineering
doganf@mst.edu;
http://mse.mst.edu/facultystaffandfacilities/dogan/

Recent Funding

DARPA, ONR, AFRL, NSF,
Leonard Wood Institute, Industry Partners

Keywords

- #CeramicScience, #Superconductors, #FuelCells, #Dielectrics, #Capacitors, #EnergyStorage, #NanoComposites

Recognitions

- Best Contribution Award; Science and Technology of Advanced Materials, 2013
- Campus Challenge II Award, Air Force Res Lab 2006
- Fellow: American Ceramic Society

DEPARTMENT OF ENGINEERING MANAGEMENT AND SYSTEMS ENGINEERING

Computational Intelligence for Price and Volatility Forecasting, Economic Modeling, and Risk Management

Intelligent Volatility and Price Forecasting

- Forecasting Volatility and Stock Option Strike Prices for Hedging and Financial Risk Management
- Intelligent Technical Trading and Investing Rules

Financial Decision Support Systems

- Adaptive Stock Index Trading Decision Support Systems
- Intelligent Portfolio Management

Economic Loss Estimation; Cost-Benefit Analysis

- Estimation of Direct and Indirect Economic Loss from Earthquake Damaged Bridges; Cost-Benefit Comparison

Energy Investment Analysis

- Market-Oriented Models for Transmission Investment
- Economics of Alternative Energy Investments & Biofuels

Intelligent Systems and Economic Models for Financial Decision Making, Investment, and Risk Management

PoC: David Enke, Professor, EMSE, Missouri S&T, 221 Engineering Management, Rolla, MO, 65409-0370, 573-341-4749, enke@mst.edu, http://web.mst.edu/~enke/

Past Funding Sources

- The Boeing Company
- New York State Gas and Electric
- Ameren
- King Saud University

Keywords

- #Computational Intelligence, #Forecasting, #Price Estimation, #Volatility Modeling, #Economic Modeling, #Risk Management, #Neural Networks, #Evolutionary Computation, #Energy

Recognition

- Eight best paper awards for research (journal & proceedings)
- Twelve teaching awards (on-campus and distance)
- Advisor for three students who have won outstanding graduate student research awards

DEPARTMENT OF ENGINEERING MANAGEMENT & SYSTEMS ENGINEERING

REINFORCEMENT LEARNING & ANALYTICS

Disaster Management

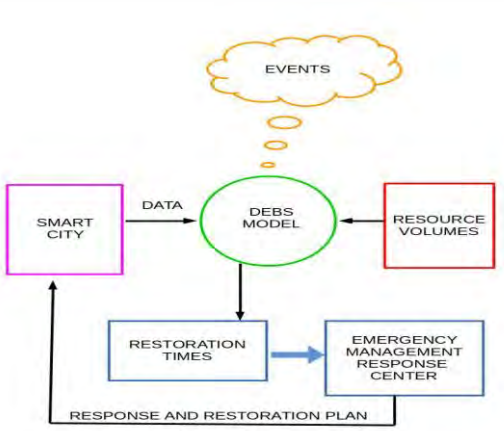
- Post-Earthquake Disaster Response
- Risk Assessment and Discrete-Event Simulation

Reinforcement Learning

- Actor-Critic Algorithms
- Risk-Adjusted Controls

Operations Management

- Total Productive Maintenance
- Queueing Approximations
- Airline Revenue Management



My research is focused on modeling and optimization of large-scale discrete-event systems

Abhijit Gosavi, Ph.D.
Associate Professor
210 EMAN BLDG,
Department of Engineering Management & Systems Engineering, Rolla 65409

Funding

- National Science Foundation
- Institute of Industrial & Systems Engineering

Keywords

- Data Analytics, Reinforcement Learning, Discrete-Event Simulation, Disaster Management, and Total Productive Maintenance

Recognition

- Second Runner-Up for Best Paper Award at Complex Adaptive Systems Conference, 2015

DEPARTMENT OF MECHANICAL AND AEROSPACE ENGINEERING

Fluid/Gas Dynamics, Plasma Science and Engineering

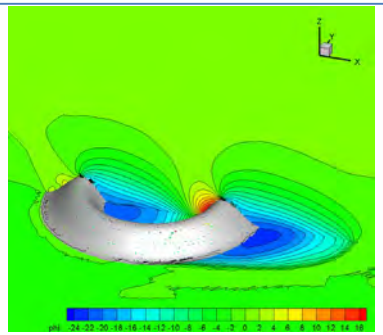
Fluid/Gas Dynamics

- Computational Fluid Dynamics (CFD) and Direct-Simulation Monte Carlo (DSMC) modeling of gases
- First-principle-based particle simulation algorithms for complex fluid problems – wind borne debris in tornado, particulates in advanced manufacturing

Plasma Science and Engineering

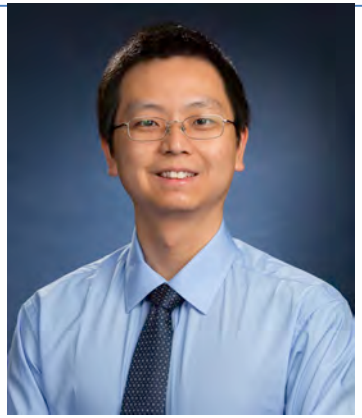
- High-fidelity kinetic modeling of plasmas
- Ground laboratory investigations of plasma phenomena for both ground and space applications – from advanced manufacturing to lunar surface exploration

- Large vacuum chamber (6-ft diameter, 10-ft long)
- Plasma source(s)
- CPU/GPU supercomputers



Experimentation/Modeling of Space Plasma

PoC: Daoru Han, Ph.D.
Assistant Professor
Mechanical & Aerospace Engineering
handao@mst.edu



Funding

- NASA-EPSCoR Missouri
- AFOSR

Keywords

- #FluidDynamics, #Plasma #Space

DEPARTMENT OF CIVIL, ARCHITECTURAL, AND ENVIRONMENTAL ENGINEERING

Smart Transportation Systems, Computing and Data Science

Smart Transportation Systems

- Connected and Autonomous Vehicles
- Electric Vehicles
- Active Traffic and Demand Management

Transportation Big Data Analytics

- Mobility Behavior Modeling and Analytics
- Machine Learning and Optimization
- Multi-Source Transportation Data Mining

Traffic Flow and System Modeling

- Traffic Flow Modeling and Applications
- Dynamic Traffic Assignment
- Origin-Destination Demand Calibration

Connecting Technology, Big Data, Computational Intelligence and Traffic Fundamentals for a Smarter Transportation System

XianBiao (XB) Hu, Ph.D.
Assistant Professor
Civil, Architectural & Environ. Eng.
xbhu@mst.edu (+1)-573-341-6178

Funding

- US Department of Transportation, Department of Energy, Department of Education, Federal Highway Administration, Missouri Department of Transportation, Colorado Department of Transportation

Keywords

- Smart Transportation Systems, Connected and Autonomous Vehicles, Electric Vehicles, Big Data, Artificial Intelligence, Computational Intelligence;
- Mobility Modeling, Traffic Flow Theory, Dynamic Traffic Assignment, Traffic Operation and Safety;

Recognitions

- Excellent Paper Award. 2018 World Transport Convention
- ASCE ExCEEd fellowship

MISSOURI UNIVERSITY OF SCIENCE AND TECHNOLOGY

Advanced Sensors Enable New Frontiers in Basic & Applied Research

Research Thrust

➢ Innovating Advanced Fiber Optic Sensor Systems

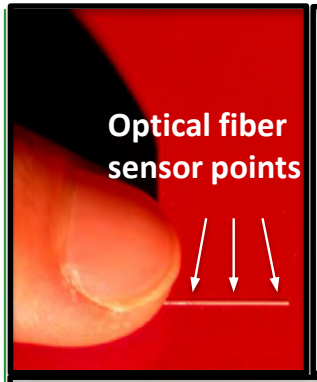
- Human hair-like sensors (small size, light-weight, immune to EMI)
- Spatially-distributed, high-speed sensing (multiple sensors per fiber)
- Diverse measurement capabilities (pressure, strain, temperature, inclination, chemical threats, flow, EM fields, etc.)

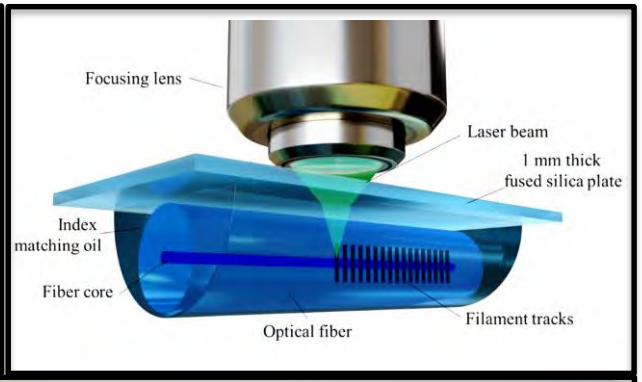
➢ Micromachining Novel Sensors and Devices

- Femtosecond laser micro-machining of photonic devices
- Lab-in-a-fiber
- Optical waveguide fabrication
- Optofluidics (microfluidics and optics)

➢ Applying Sensors with Ultrahigh Sensitivity and Resolution in Basic & Applied Research

- Fiber optic sensors in harsh environment (e.g., steel industry)
- Fiber optic sensors for military applications
- Fiber optic sensors for structural health monitoring applications
- Novel coaxial cable sensors for human health applications






MS&T Linear Impactor System

Principal Investigator

Jie Huang, Assistant Professor
Electrical and Computer Engineering
Missouri S&T
jieh@mst.edu; (573) 341-4836

Recent Funding: (~$8M) NSF, NIH, ARL, DOE, AFOSR, National labs, PSMRC, and select private companies.

Awards

- Faculty Excellence Award at Missouri S&T 2019
- Research Momentum Award at Missouri S&T 2019
- Economic Development Award at Missouri S&T 2019
- IEEE St. Louis Section Outstanding Researcher 2019

Keywords

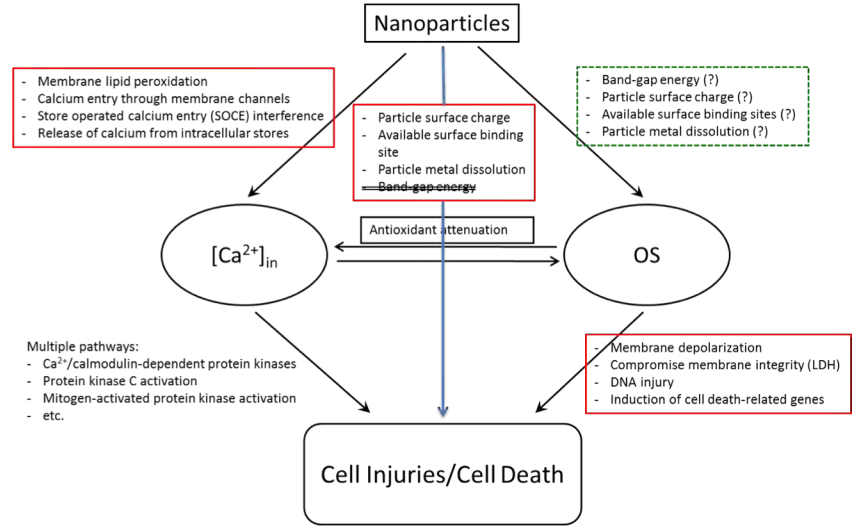
- #Fiber optic sensors, #Femtosecond laser micro-machining, #Microwave photonics, #Measurement and instrumentation

Missouri S&T | NIH | NSF | Los Alamos National Laboratory | LWI Leonard Wood Institute

Lightwave Technology Lab
Missouri S&T Blast Lab

Nanobiotechnology and Toxicology

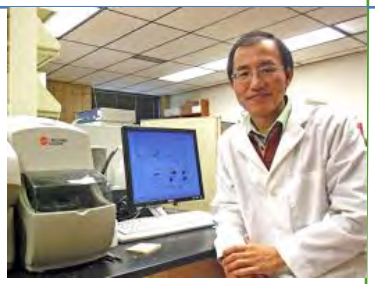
- Drug Delivery Platforms
  Develop nanocarrier platforms to deliver biologically active molecules *in vitro* and *in vivo* for basic science research and biomedical applications such as disease treatment (e.g., cancer, brain injuries) and tissue regeneration (e.g. bone regeneration)
- Toxic or Injurious Effects by Environmental Stressors
  Investigate adverse health effects caused by environmental physical and chemical factors. Identify pathways of injuries that lead to better and efficient disease treatment
- Environmental Toxicology
  Study toxic effects of environmental chemicals such as pharmaceuticals, phytochemicals, e-cigarette, and industrial chemicals on humans and the environment
- Indoor Pathogens (Bioaerosols) and Inhalation Biology



Nanomaterial toxicity involves multiple cellular and molecular signaling pathways

PoC

- Yue-Wern Huang, Professor
- E-Mail: huangy@mst.edu
- Website: web.mst.edu/~huangy
- Phone: 1-573-341-6589



Funding

- Funding agencies: NSF, NIH, USEPA, US Fish and Wildlife Service, US Geological Survey, Missouri DNR, Missouri Department of Conservation, St. Louis Zoo, Doe Run Company

Keywords: Drug delivery; Toxicology; Nanomaterials; Tissue regeneration; Indoor pathogens (bioaerosols); Antimicrobial materials

Publications and Recognitions:

- > 60 peer-reviewed journal papers & 12 book chapters in 20 years
- Plenary speaker of two international conferences
- 23 Public media exposure; 35 invited seminars of internationally known institutes
- Three editorial boards & EPA TSCA Science Advisory Committee on chemicals
- S&T Faculty Excellence Award and Faculty Research Award

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

Electromagnetic Compatibility & High-Speed Digital System

Inter/Intra Electromagnetic Interference

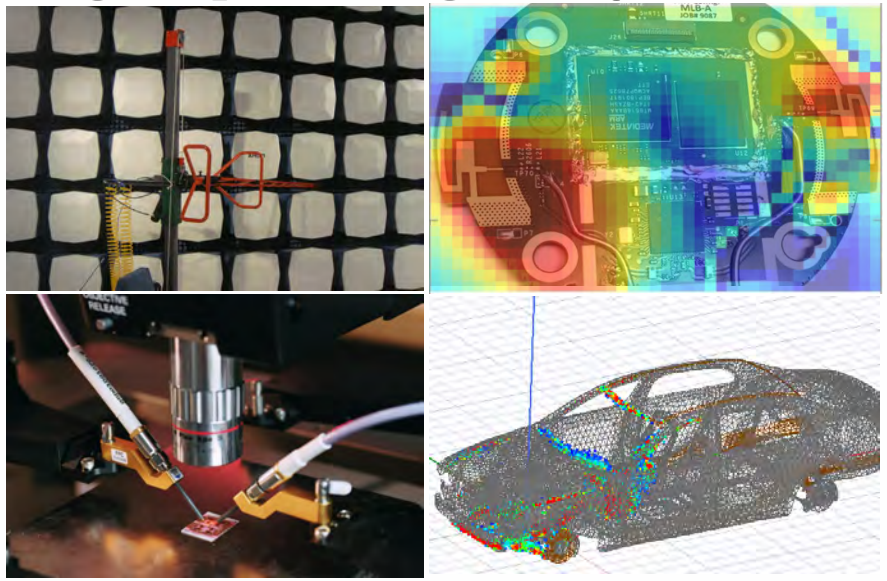
- RF desensitization of IoT wireless devices
- Conducted and radiated emission
- Electromagnetic framework

Signal/Power Integrity for High-Speed Systems

- Power distribution network
- High-speed serial link
- Printed circuit board characterization/design
- Machine-Learning based optimization

Intentional EMI/Hardware Security

- Intentional electromagnetic interference
- Inaudible command injection to smart speakers
- Battery security



Electromagnetic Design for IoT Devices and High-Speed Digital Systems

PoC: Chulsoon Hwang, Assistant Professor
Electrical and Computer Engineering
hwangc@mst.edu (573)341-4455
homepage: http://emclab.mst.edu

Awards

- Google Faculty Research Award 2019
- Faculty Research Award at Missouri S&T 2019
- Best Paper Awards at DesignCon 2018 & 2019
- Best Paper Award at IEEE EMC&SIPI 2019

Funding

- Apple, Google, IBM, Amazon, Sony, ASUS, Hynix, Samsung, Ford, Deere and Company, HMC, etc.
- NSF, Dept. of Education

Keywords

#Electromagnetic interference #RF Desensitization #Signal integrity #Power distribution network #PCB #Hardware security #Electromagnetics

DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING

Power Converters for Microgrids and Electric Vehicles

Renewable Energy Optimization

- Dynamic programming approaches to minimize energy cost when solar energy and battery storage are available

Microgrid Stability Analysis

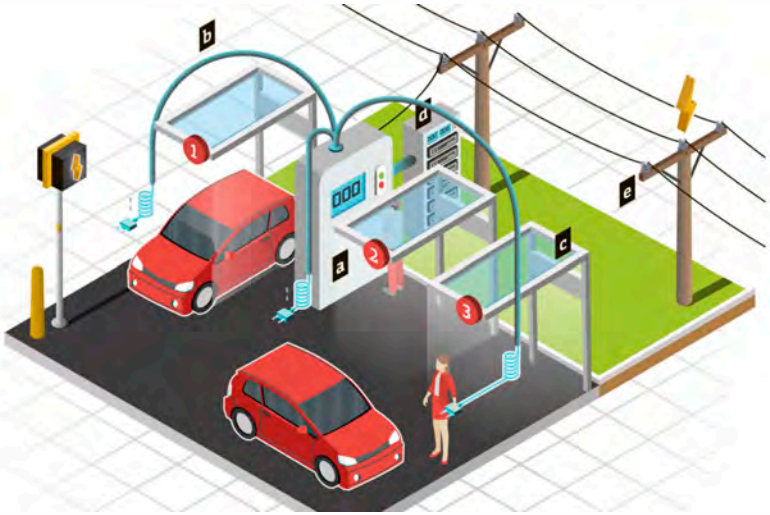
- Microgrids have limited resources, so they are fragile

Extreme Fast Charging of Electric Vehicles

- Charge an EV as fast as filling a gas tank—requires new power conversion approaches, new energy storage systems, and grid support algorithms

Cyber-Physical Systems

- How can we assure stability and security in a distributed system of power generators and consumers?



Conceptual extreme fast charging station to charge an electric vehicle in under 10 minutes.

PoC: Jonathan Kimball, Professor and Interim Director of CREE,
kimballjw@mst.edu,
www.jonathankimball.com

Funding

- National Science Foundation, Department of Energy, NASA

- **Keywords**
  - #Invariants, #Microgrids, #Solar, #XFC
- **Recognitions**
  - Awards: Faculty Excellence Award, February 2015; Faculty Research Award, December 2018
  - General chair, IEEE Applied Power Electronics Conference 2017, www.apec-conf.org
  - Dean's Scholar of the College of Engineering and Computing, AY17-18

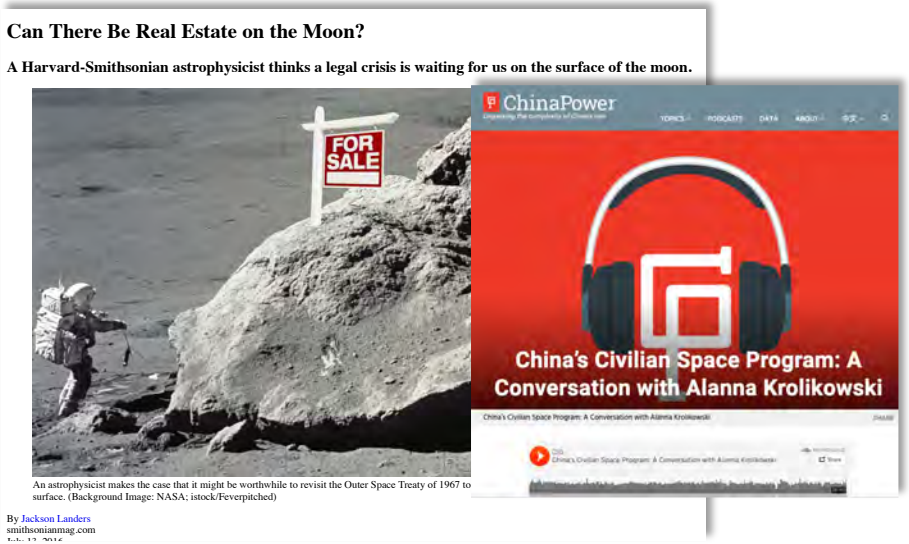
MISSOURI S&T

Innovation and Strategic Trade

Policy in the United States and China

Research Topics

- Aircraft, spacecraft, and statecraft
  - U.S.-China trade in commercial aerospace items
  - Innovation, industrial, trade, and export control policy
- Governance of lunar resources
  - Mechanisms to manage crowding and interference at lunar sites targeted by forthcoming missions
  - International management of concentrated lunar resources
- National responses to Huawei's 5G equipment
  - Policies adopted in Germany, Japan, and the UK
  - Trade-offs between trade and security interests



PoC

- Alanna Krolikowski
- Assistant professor of political science
- akro@mst.edu

Funding

- University of Missouri Research Board grant (active)

Keywords

- #China, #spacepolicy, #innovationpolicy, #spaceresources

Recognitions

- CASB teaching award, 2020
- Quoted in *Washington Post*, "China increasingly challenges American dominance of science," 2018
- Testimony before the U.S.-China Economic and Security Review Commission, 2015
- Fulbright, Harvard-Princeton China and the World fellowships

DEPARTMENT OF ENGINEERING MANAGEMENT AND SYSTEMS ENGINEERING

Large-Scale Complex Systems Design

Value-Based Systems Design

- Evaluation of Subjective Preference in System Design
- Stochastic Modeling of Descriptive Human Decision Making
- Organization and System Structure Correlation

Multidisciplinary Design Optimization

- Definition of Complex System Architecture and Environments
- Quantification of System and Environment Couplings for decision making

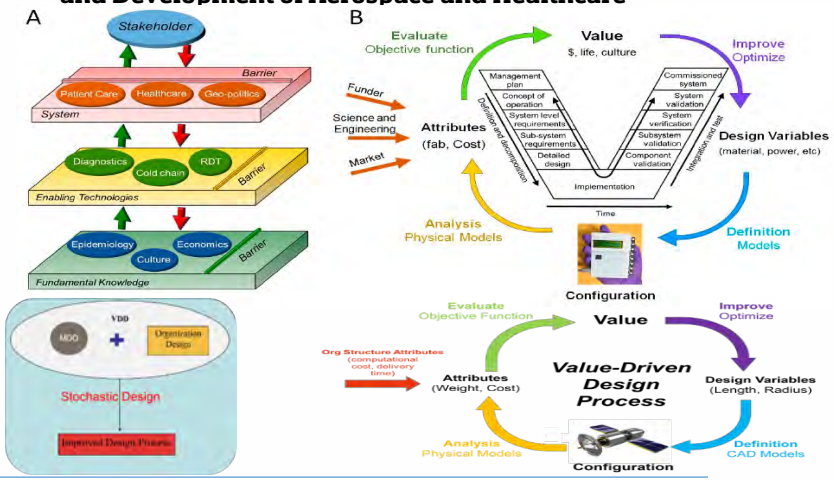
VR/AR for Complex System Decision Making

- High risk decision-making exploration for complex systems

Healthcare Systems Design

- Complex System Driven Epidemiology
- Frugal Innovation for Developing/Rural Areas

Utilization of Organization Design to Enhance Design and Development of Aerospace and Healthcare



PoC: Benjamin Kwasa, Ph.D
Assistant Professor
Engineering Management & Systems Eng.
kwasab@mst.edu

B.Sc, Aerospace Engineering

M.Eng, Systems Engineering

P.hD, Aerospace Engineering

Keywords

- Multidisciplinary Design Optimization; Value-Based Systems Engineering; Decision Analysis; Complex Systems Design; Aerospace Systems Design; Healthcare Systems; Unmanned Aerial Systems; Frugal Innovation; Virtual and Augmented Reality

Recognitions

- Award: Teaching Excellence Award, ISU 2016

Advanced Manufacturing Signature Area

Hybrid Additive/Subtractive Manufacturing

- Integrate additive and CNC machining
- Rapid manufacturing of precision metal parts

Additive Manufacturing Process Modeling

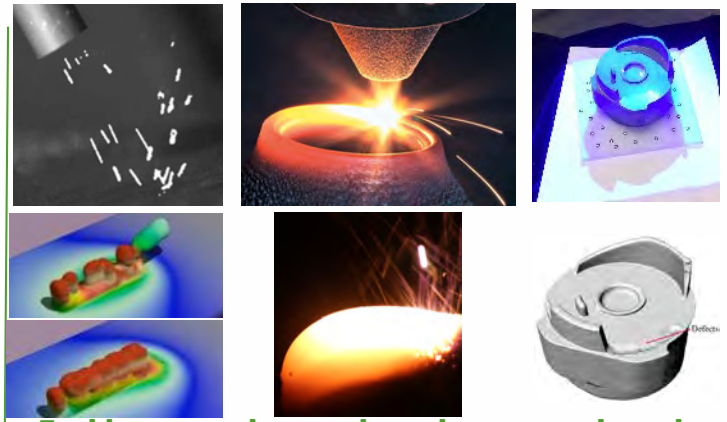
- Multi-scale multi-physics AM accelerated modeling
- In-situ monitoring and control, AM qualification

Repair Using Additive Manufacturing

- Automated repair using hybrid manufacturing process
- Stronger than the undamaged parts

Advanced Material Additive Manufacturing (AM^2)

- Integrate AM process modeling, monitoring, and control to fabricate advanced materials
- Functional Gradient Materials (FGM), elemental powder fabrication, digital material fabrication



Enable new products and novel processes through additive manufacturing technologies

PoC: Frank Liou, Michael and Joyce Bytnar Professor
liou@mst.edu; 573-341-4603

Funding

- AFRL, Army, DARPA, DOE, DoEdu, DOT, INL, NASA, NAVAIR, NIST, NSF, etc.
- Industry: Boeing, Cummins, DMG/MORI, EWI, Ford, GEA, GKN, Honeywell, PINE, Rolls Royce, S^3 Inc., Spartan, Spirit, Titanova, Toyota, Westinghouse, etc.

Keywords

- Metal Additive Manufacturing, Process, Modeling, System Integration, Sensor, Control, Advanced Materials

Recognitions

- SME Frederick W. Taylor Research Medal, 2020
- • Distinguished Investigator Award, ISC, 2019
- Publication in Nature: Scientific Reports: 2017, 2018
- Best Paper awards, 2005, 2010, 2015, 2018
- Important innovations at Missouri S&T, 2013, 2015

Nanostructured Materials Prepared by ALD/MLD

Surface Science and Surface Functionalization

- Chemistry of atomic/molecular layer deposition (ALD/MLD)
- Surface functionalization by ALD/MLD

Nanostructured Materials for Catalysis

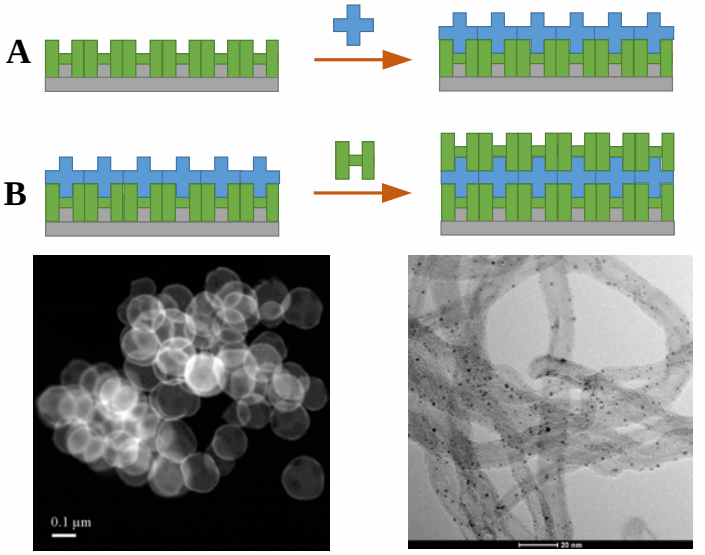
- Highly active, thermally stable catalysts for various reactions prepared by ALD/MLD, including dry reforming of methane, CO_2 reduction to form methanol and then dehydrogenation to dimethyl ether
- Size-selective catalysts

Nanostructured Materials for Energy Storage

- Lithium/sodium ion batteries
- Solid oxide fuel cells

Nanostructured Materials for Environmental Remediation

- Gas separation and water treatment



High quality ultra-thin films or highly dispersed metal nanoparticles can be prepared by ALD

PoC: Xinhua Liang, Associate Professor, Chemical and Biochemical Engineering
Email: liangxin@mst.edu
http://web.mst.edu/~liangxin/

Funding

- National Science Foundation
- Department of Energy
- Honeywell Federal Manufacturing and Technologies
- ACS-Petroleum Research Fund and industries

Keywords

Atomic Layer Deposition (ALD), #Molecular Layer Deposition (MLD), #Thin Film, #Coating, #Catalysis, #Lithium Ion Battery (LIB), #Water Treatment

Recognitions

- Awards: 2019, 2015, Faculty Research Award, Missouri S&T
  2019, Research Exergy Award, CEC, Missouri S&T
  2018, Faculty Excellence Award, Missouri S&T
  2016, Dean's Scholar, Missouri S&T
  2015, ACS-PRF DNI Award

MISSOURI UNIVERSITY OF SCIENCE AND TECHNOLOGY

Modeling Big Data in Biology and Medicine for Precision Medicine

Causal discovery of genomic variants for diseases

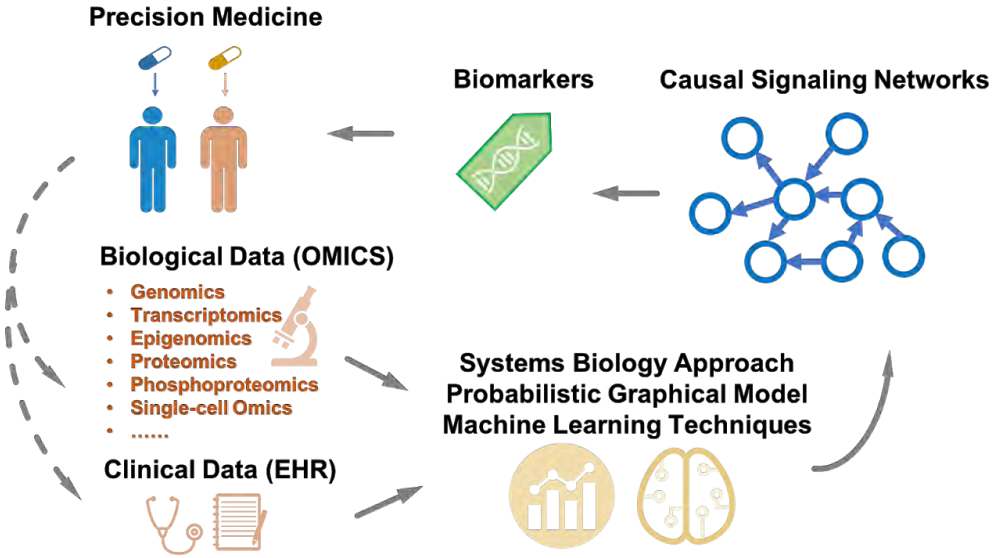
- An instance-specific causal machine learning framework
- Whole genome sequencing and SNP data from FHS

Multi-omics data analysis to reveal the causal signaling networks underlying diseases

- RPPA, mRNA, DNA mutation data from cancer patients
- Causal Bayesian Networks (CBNs)

Machine learning-assisted material design

- Apply statistical analysis and machine learning techniques in collaborators' disciplines for data mining
- Prediction of material properties with its composition and processing



Informatics and Precision Medicine

Jinling Liu, Assistant Professor
Engineering Management &
Systems Engineering,
and Biological Sciences
Missouri S&T
Jinling.liu@mst.edu; (573) 341-4150

Funding: NHLBI, NIH

Awards

- ❖ BioData Catalyst Fellow, NHLBI, NIH, 2020-2021
- ❖ National Library of Medicine Fellowship, 2017-2019

Keywords

 # Big Data Analytics, # Machine Learning, # Biomedical Informatics, # Precision Medicine, # Systems Biology, # Causal Inference

Missouri S&T

NIH National Heart, Lung, and Blood Institute | BioData CATALYST

Intelligent Systems Center
Center for Biomedical Research

DEPARTMENT OF ENGINEERING MANAGEMENT AND SYSTEMS ENGINEERING

Resilient Critical Infrastructure Systems

Planning Models and Tools

- Characterization of socio-critical systems interdependence
- Resiliency Risk and Uncertainty Calculation Tools.

Visualization and Data Acquisition Modeling

- Social Network Data Analytics
- Visualization and High Performance Computing Tools

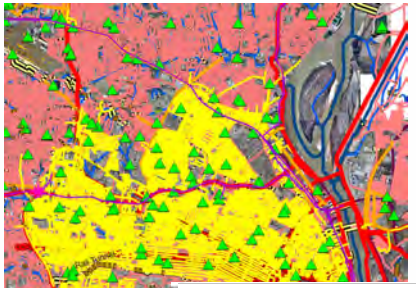
Extreme Event Restoration Prioritization Modeling

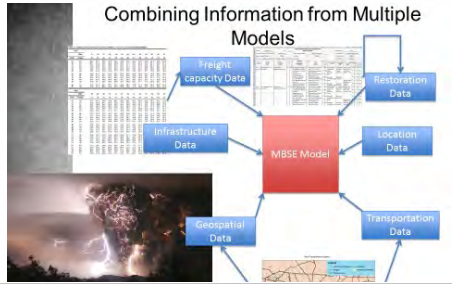
- Systems Architecture of Complex, Resilient Systems
- Resource Allocation Modeling and Tools

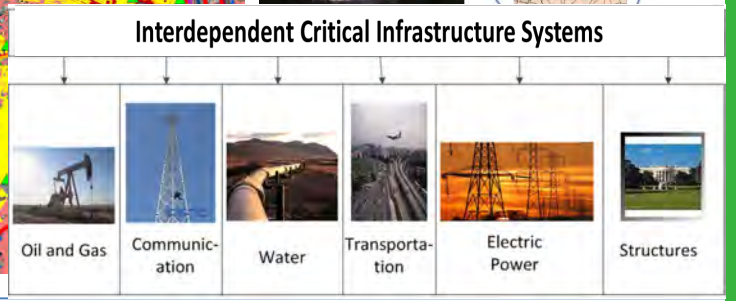
Resilience Protocols

- Decision analysis frameworks planning
- Data Analytics and Informatics Ontologies

Use Complex Adaptive Systems Theory to develop community planning tools for Smart, Resilient Systems







PoC: Suzanna Long, Ph.D. P.E.M.,
Professor and Department Head,
Engineering Management & Systems Eng.
longsuz@mst.edu;
http://emse.mst.edu/facultystafffacilities/emsefaculty/index.html

Funding

- US Department of Transportation, Federal Highway Administration, National Science Foundation, U.S. Department of Energy, U.S. Geological Survey, Missouri Department of Transportation, USACE.

Keywords

- Resilient Systems; Geospatial Data Analytics; 3DEP Modeling; Interdependent Critical Infrastructure Systems; Disaster Restoration Modeling

Recognitions

- Award: Missouri S&T Woman of the Year, 2016.
- Award: University of Missouri President's Award, 2013.
- Award: AASHTO High Value Research Project Winner, 2012.
- Fellow: ASEM.

DEPARTMENT OF COMPUTER SCIENCE

Securing Artificial Intelligence & Internet of Things

IoT Security

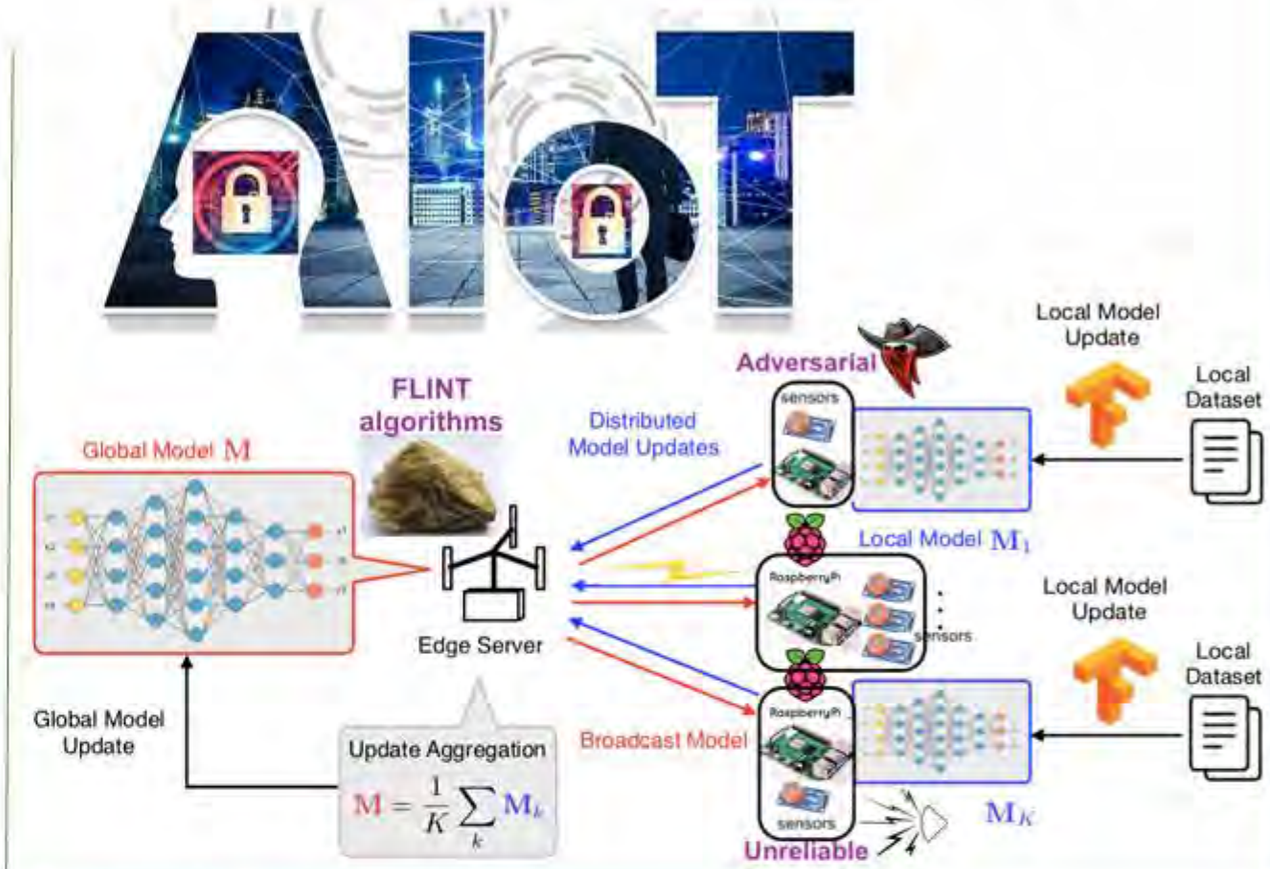
- Anomaly detection in IoT using machine learning
- Design of Defense/Attack mechanisms for IoT

Adversarial Machine Learning

- Robust learning models that are resistant to poisoning, evasion, and privacy attacks
- Robust Federated Learning in adversarial and unreliable environments

AI-IoT Integration

- AI-empowered IoT systems with profound economic and societal impact



PoC: **Tony T. Luo**
Associate Professor
Department of Computer Science

E-mail: tluo@mst.edu
Homepage: https://tluocs.github.io

Funding: National Science Foundation 2020-2023 ($500,000)

Keywords

- Internet of Things, Machine Learning, Cyber Security, Cyber Physical Systems

Recognitions

- IEEE Senior member
- Best Paper Award nominee: INFOCOM 2015 | Best Paper Award: ICTC 2012 | Best Student Paper Award: AAIM 2018
- Media coverage: IEEE Spectrum Magazine 2016
- Top 1% Reviewers in Computer Science, 2017-2018

DEPARTMENT OF COMPUTER SCIENCE

Cyber Security & Machine Learning in Mobile and IoT Networks

Security and Risk Assessment in Sensor Cloud Computing

- Risk Assessment in Sensor Cloud Computing
- Data Security and Assess Control in Cloud Computing
- Cloud-assisted Cyber Physical System and Security

Content Management and Security in Delay-Tolerant networks

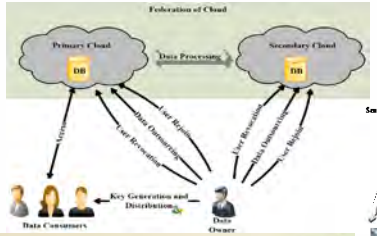
- Situational-awareness in Delay-tolerant Networks
- Task scheduling in UAV Networks
- Ride-sharing and Transport Management for Smart City Applications
- Mobile Data Management

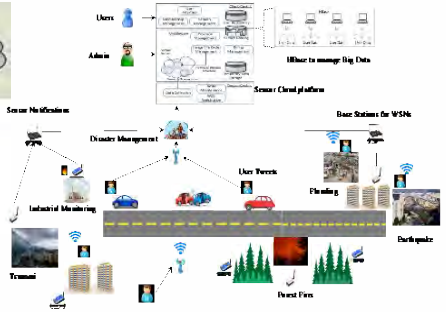
Machine Learning and Big Data Management

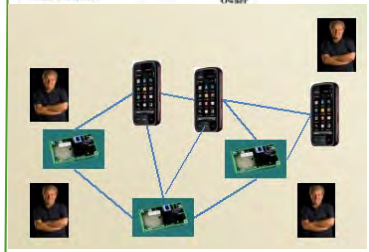
- Machine learning for anomalies and malicious activities
- Machine learning for Big data management

Blockchain

- Access control and security within Blockchain







Sensor Cloud, Secure Cloud, Combat Cloud, Blockchain network, ML and Mobile Data Management

PoC: Sanjay Madria, Curators' Distinguished Professor
Dept. of CS, Ph. 573-341-4856
madrias@mst.edu

Funding Agencies (5 years)

- NSF and NIST
- Boeing, Honeywell, and ORNL
- Air Force Research Lab, Army Research Lab, Army Research Office
- Department of Education

Keywords

- #Sensor Cloud, #Risk Assessment, # Mobile Data Management , # Cloud Security, #Delay-tolerant Networks, # Machine Learning, # Blockchain , # Combat Cloud

Recognitions

- Awards: Five IEEE Best Paper Awards, Six Faculty Research Award, NRC and AFRL Fellowships
- Pub.: 275+ journal and conference publications and 2 books
- Service: PC Chair, General Chair, Steering committee members, Associate editors

DEPARTMENT OF BUSINESS AND INFORMATION TECHNOLOGY

Human-Computer Interaction, User Experience, and Usability Evaluation

Design Science

- Create and evaluate IT artifacts intended to solve identified problems in smart living, business, and organizational context
- Use of empirical approaches (e.g., experiment, case study, survey) to evaluate IT artifacts in appropriate contexts

Human-Computer Interaction/User Experience

- Designing for smart living environment (e.g., Internet of Things)
- Designing for information assurance (e.g., privacy and security)
- Designing aesthetic and pleasurable user interface

Usability Evaluation

- A/B testing, usability testing, heuristic evaluation, contextual interview, think-aloud protocol, retrospective process tracing
- Eye-tracking, skin conductance response, electroencephalogram (EEG)
- Self-reported measures, computer logs, facial expression analysis
- Dark and bright sides of IT/IS use

Eye-tracking for Website Evaluation

Recognition

- Ranked #6 (based on straight rank) in the list of most prolific authors in human-computer interaction research in information systems Source: Zhang et al. (2010). "Human-Computer Interaction," in W. Huang (ed.), *Management Information Systems*, Tsinghua University Press, Beijing, China. Available at: http://melody.syr.edu/pzhang/publications/TU_07_Zhang_etal_HCI.pdf

PoC: Fiona Fui-Hoon Nah, Professor
Department of Business & Info Technology
Email: nahf@mst.edu
Phone: 573-341-6996

Funding

- National Science Foundation
- IBM Research & Education Grant

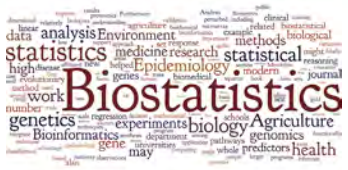
Keywords

- Human-computer interaction; user experience; usability; eye-tracking; electroencephalogram (EEG); interface design; smart living; usable security; neuro-IS

Selected Publications

- Stephanidis, C., et al., (2019). Seven HCI Grand Challenges, *International Journal of Human-Computer Interaction*, 35(14), pp. 1229-1269.
- Adapa, A., Nah, F., Hall, R., Siau, K., & Smith, S. (2018). Factors Influencing the Adoption of Smart Wearable Devices, *International Journal of Human-Computer Interaction*, 34(5), pp. 399-409.
- Smith, S., Nah, F., & Cheng, M. (2016). The Impact of Security Cues on User Perceived Security in E-commerce, *Lecture Notes in Computer Science 9750*, T. Tryfonas (editor), Springer, pp. 164-173.
- Sharma, R., Nah, F., et al. (2016). Smart Living for Elderly: Design and Human-Computer Interaction Considerations, *Lecture Notes in Computer Science 9755*, J. Zhou & G. Salvendy (editors), Springer, pp. 112-122.
- Nah, F., Eschenbrenner, B., & DeWester, D. (2011). Enhancing Brand Equity through Flow and Telepresence: A Comparison of 2D and 3D Virtual Worlds, *MIS Quarterly*, 35(3), pp. 731-747.

Gayla Olbricht
olbrichtg@mst.edu
Associate Professor of Statistics
Mathematics & Statistics Department

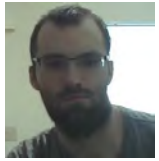


Implementing *statistical methods* for inference-based analysis of biological data through collaborations with subject-matter experts

Ph.D. Students (Genomics)


Tarek Bennaser


Yuqing Su


Arnold Harder


Daniel Alhassan

Master's Students

TBI


Sujit Subhash

Fly Sleep


Caroline Schott

Statistical Specialties

- ❖Regression Analysis/Linear Models
- ❖Markov Models
- ❖Multivariate Analysis
- ❖Targeted Learning
- ❖Functional Data Analysis

Data Specialties

- ❖ DNA Methylation
- ❖ SNP/Association studies
- ❖ Gene Expression
- ❖ *Drosophila* Activity Monitoring
- ❖ Traumatic Brain Injury

Learning based Control, Data Analytics, and Security

Networked Dynamic Systems and Resilience

- Modeling and learning based adaptive control of networked dynamic systems in the presence of network imperfections. Develop resilient schemes to mitigate cyber attacks on such systems (e.g automotive).

Autonomous Systems and Robotics

- Navigation and control of autonomous systems including formation control of multi-agent systems such as robots, UAVs. Development of deep reinforcement learning based optimal adaptive control.

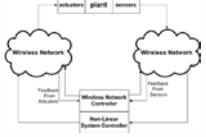
Cyber-Physical Systems (CPS) and Resilience

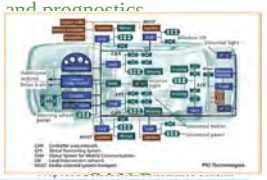
- Develop modeling and control of CPS with applications to automotive, smart grid, automotive systems and network enabled manufacturing. Mitigate attacks on sensor, actuator and cyber systems using learning methodology.

Cyber Manufacturing and Bigdata

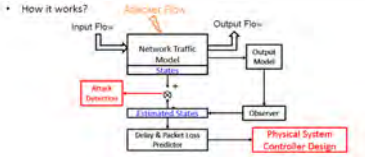
- Use of RFID tag to sense, and track assets in Cyber manufacturing environments. Development of novel methods for analyzing Bigdata, and diagnostics and prognostics methods for mechanical, health care, and electrical systems

Missouri S&T Mote, RFID tag for networking sensing and decentralized control, diagnostics and prognostics

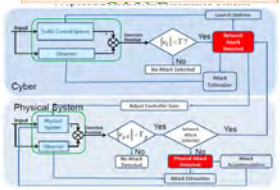




Formation control of UVV and mobile robo



Attacks on Networked Dynamic Systems



Resilience Scheme

PoC: Jag Sarangapani
Rutledge Emerson' Distinguished Professor
Electrical and Computer Engineering
Systems; sarangap@mst.edu;
http://ece.mst.edu/facultystaffandfacilities/facultydirectory/jagathansara

Recent Funding

National Science Foundation, Dept of Education, Honeywell.

Keywords

- Deep Reinforcement Learning-based Optimal Adaptive Control, Cyber-physical Systems, RFID, Autonomous Systems & Robotics, Bigdata Analytics

Recognitions

- Multiple Faculty and Teaching Excellence Awards
- 21 US and International Patents Awarded
- 2018 IEEE Control System Society Transition to Practice Award
- Fellow of the IEEE (USA), National Academy of Inventors, IET (UK) & IMC (UK)

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

Dependability for Intelligent Systems

Examples of Dependability Attributes Studied

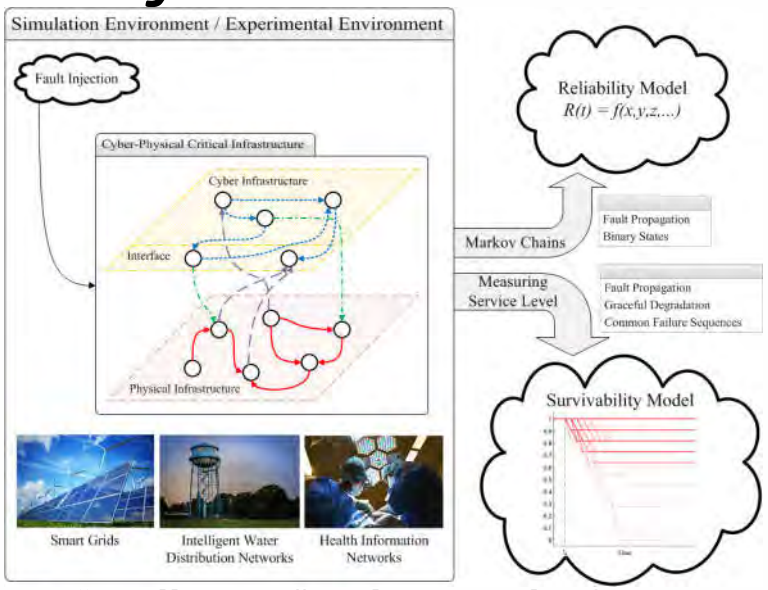
- Reliability: Probability of system remaining functional
- Availability: Percentage uptime
- Survivability: Functionality maintained after failure
- Resilience: Ability to bounce back from failure

Examples of Systems Analyzed

- Consumer electronics, autonomous vehicles, smart grids, intelligent water distribution networks

Examples of Tools and Techniques Created

- Stochastic models of dependability attributes for critical infrastructure systems
- Simulation environments that capture both the physical infrastructure and the intelligent control
- Models for detecting exposure to electrostatic discharge



Does "intelligence" make critical infrastructure systems more dependable?

PoC: Sahra Sedigh Sarvestani
Associate Professor
Associate Chair for Distance Education
Dept. of Electrical and Computer Engineering
Dept. of Computer Science (courtesy)
sedighs@mst.edu, http://web.mst.edu/~sedighs

Funding

- National Science Foundation, Dept. of Education, US and MO Depts. of Transportation, National Security Agency, Army, Private Industry

Keywords

- Dependability, Critical Infrastructure, Autonomous Systems, Stochastic Modeling, Cyber-Physical Systems, Simulation, Failure Analysis

Recent Recognition

- Best Paper Award, International Symposium on Resilient Cyber Systems, August 2016
- Two papers cited in the NSA Science of Security Index as Significant Research in Cyber Security, 2015

MISSOURI S&T

Morality of Artificial Intelligence

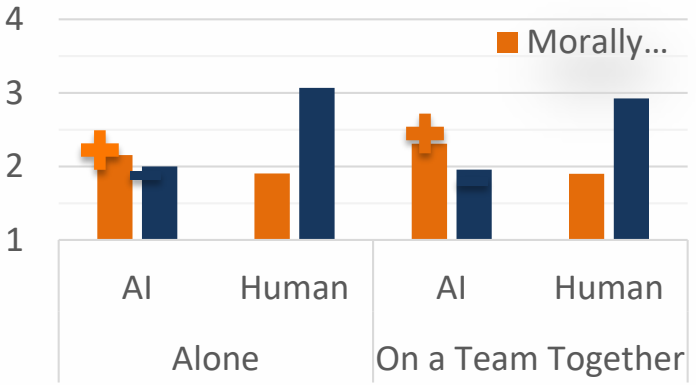
Do people perceive morality for AIs like humans?

For the exact same behaviors, people perceive that it is less wrong and more morally permissible for an AI than a human. This is true when the AI and human are working alone or together (figure).

How much mind to people judge AIs to possess?

How to people allow AIs to advise them?

Do humans and AIs on teams change the perception and judgments about that team?



Daniel B. Shank
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Psychological Science
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Funding & Award

Co-PI, National Science Foundation ($150,000)
PI, Army Research Office ($168,108)
PI, Leonard Wood Institute ($75,675)
2019 Faculty Research Award. Missouri S&T.

Other Research Areas

affective impressions, smart home products, solar village, social dilemmas, public goods dilemmas, affect control theory, games

Keywords

morality, moral perception, mind perception, attributions, impressions, artificial intelligence, AI, human-computer interaction, groups, advising, organizations, teams, affect, emotions, uncertainty

DEPARTMENT OF MECHANICAL AND AEROSPACE ENGINEERING

Physical Human-Robot Interaction

Sensory augmentation for mobility assistance

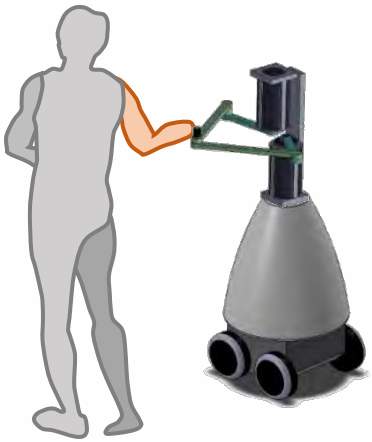
- Light-touch based assistance
- Virtual touch for increased postural awareness

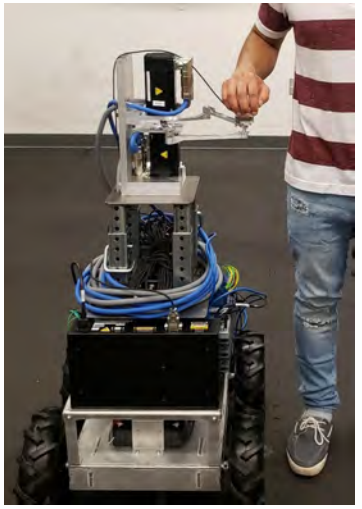
Human-like interactive robots

- Low-force, low-impedance
- Intuitive and effective walking assistance
- Motor communication through interaction forces

Rehabilitation robotics

- Motorized walking aide for older adults
- Physical assistance from smart environment
- Energy recycling from human movement





Safe, intuitive and effective physical interaction between humans and robots

PoC: Yun Seong Song, Assistant Professor
Mechanical and Aerospace Engineering
songyun@mst.edu, (573) 341-4371

Funding

- National Science Foundation (Mind, Machine and Motor Nexus – M3X)

Keywords

- Physical human-robot interaction, rehabilitation robotics, sensory augmentation

Recognitions

- PBS News Hour, “These stairs recycle your energy so they’re easier to climb”
- Other news coverages (USA, UK, Canada, Germany, Italy, Australia, Singapore, Taiwan, Korea)

DEPARTMENT OF COMPUTER SCIENCE

STRATEGIC & TRUSTWORTHY SOCIO-TECHNICAL SYSTEMS

CURRENT PROJECTS

Trustworthy Human-System Interaction

- Novel fairness notion based on **non-comparative justice**.
- Identification of fair auditors to **de-bias unknown classifiers**

Strategic Influence in Human-System Interaction

- **Strategic task recommendations** in crowdsourcing based on worker's revealed preferences and capabilities.
- **Multimodal route recommendations** for smart transportation

Resource Allocation in Fog-Enabled 5G Networks

- Near-optimal 5G resource allocation to **max. task-throughput**.
- Matching-based resource allocation for faster task completion.

Security of Inference Networks

- Theoretical limits and effective countermeasures to mitigate **eavesdropping, data falsification** and **jamming** attacks.

PoC: **VENKATA SRIRAM SIDDHARDH NADENDLA**
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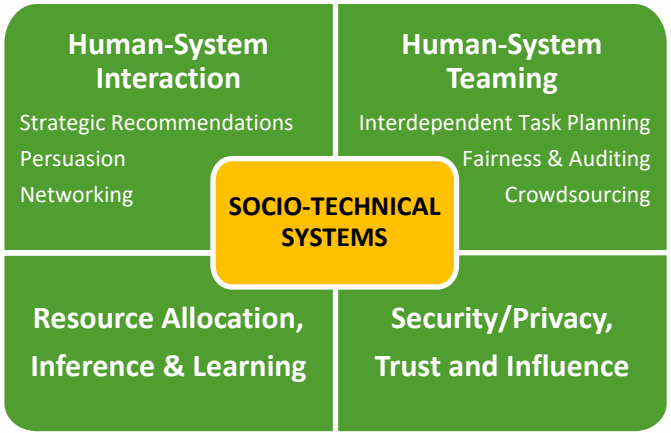
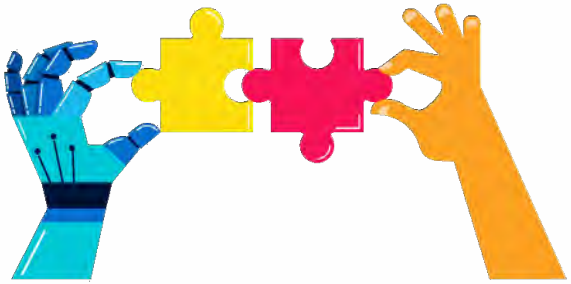
BROADER VISION





DEPARTMENT OF MINING AND NUCLEAR ENGINEERING

Materials for Extreme Environments

Nuclear materials and radiation effects in them

- Developing, characterizing and testing nuclear fuels and structural materials for energy, space and military applications

Advanced nanostructured materials

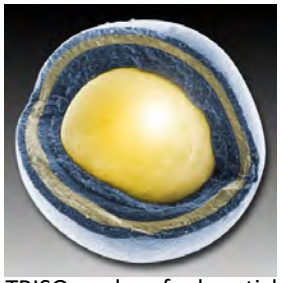
- Developing, manufacturing (including additive manufacturing), characterizing and testing advanced nanostructured materials such as steels and high-entropy alloys and ceramics for applications in extreme environments such as irradiation, hypersonic flight, and ballistic impact

Microstructure characterization

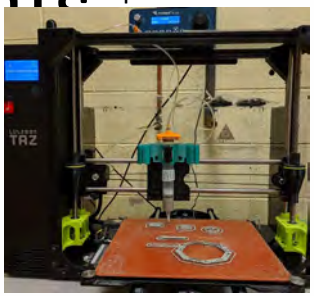
- Characterizing microstructure of materials using electron microscopy and atom probe tomography

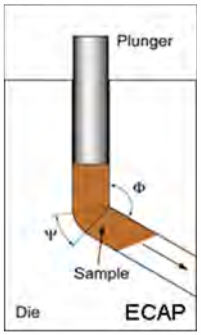
Mechanical behavior

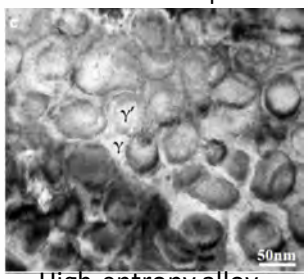
- Testing and understanding mechanical behavior of advanced materials and its correlation with



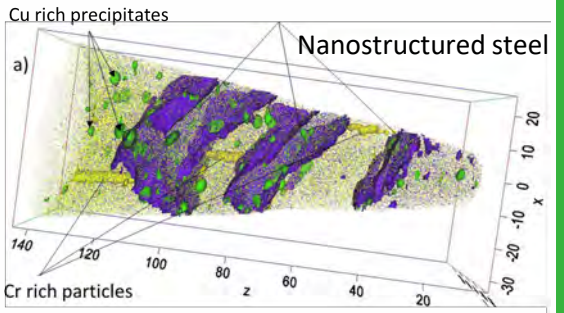
TRISO nuclear fuel particle







High-entropy alloy



Develop, manufacture, characterize and test advanced materials for applications in extreme environments

PoC: Haiming Wen, Assistant Professor
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573-341-6167

Funding

- DOE NEUP Grants
- NRC Faculty Development Grant
- Campus Seed Grants

Keywords

- #NuclearMaterials, #RadiationEffects, #ExtremeEnvironment, #HighTemperatureMaterials, #NanostructuredMaterials, #MaterialsManufacturing, #MicrostructureCharacterization, #MechanicalBehavior, #ElectronMicroscopy

Recognitions

- Award: 2016 and 2018 Dept. of Energy NEUP Awards
- Award: 2016 Idaho National Laboratory LDRD Award
- Service: Editorial Board Member of Materials Science and Engineering A, AIMS Materials Science.