Prasanth Ananth  
Technical Lead for Aerial Robotic Systems Research  
Drones, 5G and Cloud enabling Future Industrial Automation

APPLICATIONS
- Disaster Response
- Logistics and Inspection
- Smart City

RESEARCH
- Precision Landing
- Reliable Grasping
- Multi-drone Systems
Design Optimization

- Length scales from nano-meters to deca-meters
- Time scales from milli-seconds to years
- Thousands of interfaces
- Multi-physics
- Is optimal design possible?

Structural Dynamics

- Vibration and nonlinear dynamics
- Reduced order modeling
- System level analysis (macroscale)
- Simple, pointwise contact models; usually heuristic in nature
- Typical experiments use shakers, impact hammers, accelerometers
- Typical models are dynamic, finite element or reduced order models

Contact Mechanics

- Elasticity and plasticity solutions
- Static stress analysis
- Focus on the contact patches (meso- and macroscale)
- Contact models usually are large, spatially distributed, and based on Coulomb.
- Typical experiments use MTS machines or fretting rigs
- Typical models are static, high fidelity finite element

Tribology

- Wear
- Surface evolution over time
- Focus on micro- and nano-scale features
- Contact models usually are for asperity on asperity contact
- Typical experiments use tribometers or other wear rigs in addition to profilometers
- No such thing as typical models (tribology spans many disciplines…from solids to fluids to chemistry)
Hydrokinetic turbines

Innovative wind turbines

Ecological water intakes
Additive Manufacturing and Computational Design for Next Generation Lithium-ion Batteries

Corie L. Cobb, Ph.D. (clcobb@uw.edu)
Washington Research Foundation Innovation Professor in Clean Energy
Tenure-Track Associate Professor of Mechanical Engineering

1. Additive Manufacturing Methods
2. New Material Architectures
3. Computer-aided Design Tools

Focused on new manufacturing and design solutions for energy storage
How do bacteria interact with surfaces?

Jacinta C. Conrad, University of Houston

**Solid surfaces:** responsive brushes for antifouling

**Liquid surfaces:** adhesion for bioremediation
Technology Drivers:
Desalination and chemical filtration membranes

Knowledge Gaps:
How is nanopore flow influenced by wall structure?
How do we describe phase changes of nanoconfined fluids?

The Center for Enhanced Nanofluidic Transport
John Cumings, University of Maryland
Geophysical constraints on the reliability of solar and wind power worldwide

Dan Tong et al. (in prep)
SAINT-GOBAIN’S VISION FOR GLASS AS DATA CARRIER

Alicia Dröge
Physicist, Project Leader
Jeffrey S. Erickson
Engineer, U.S. Naval Research Laboratory

Research Interests: Distributed Microsensors for Chemical Detection
Current Applications: Industrial monitoring, diver safety assessments, smart agriculture, stadium security, unexploded ordinance detection
Atomic Imaging in Graphene Liquid Cells

We’d like to study many chemical reactions and biological systems in liquid environments but imaging in liquids is highly challenging.

Our graphene-cells are compatible with the latest transmission electron microscopes (TEMs) and allow atomic scale imaging and elemental mapping in liquids.

D. J. Kelly et al Nano Lett. 2018, 18, 2, 1168-1174
Solid Ion Conductors
Next generation energy storage, conversion, and electrochemical fuel production systems

X-ray Science
Observing directly and indirectly materials
In far-from-equilibrium forms

Low-Dimensional Materials
Flexible Electronics
(1) Selective removal of A-Elements
(2) Processing effects on surface properties
(3) Electrical and Electrochemical Properties

Multi-Material Manufacturing
Colloidal Processing of for Energy Conversion and Reactive Materials Applications

Keywords:
Solid State Batteries, Synchrotron Science Manufacturing Interfaces

Kelsey B. Hatzell
Vanderbilt University

PhD Material Science
Drexel University

Post-Doc
Berkeley Lab

Colloidal Processing of for Energy Conversion and Reactive Materials Applications
Background: PM$_{2.5}$ contributes to millions of premature deaths per year globally.

Problem: numerous sectors (e.g., electricity generation, cars, fires, ...), and contributions from local emissions convolved with sources in upwind cities, states, countries, and continents – what is the role of each?

Approach: modeling and satellite remote sensing.

Applications:
- Source “footprints” for specific urban areas (e.g., Seoul and Washington DC)
- Health impacts of fires in Brazil
- International import & export of premature deaths from PM$_{2.5}$ exposure
- Integration with energy & trade models, decision support tools

Example: international deaths caused by domestic transportation emissions
Upskilling the future workforce using AI

Employment growth and decline by occupation, % change labor demand, midpoint automation

M. Ehsan Hoque
Assistant Professor
University of Rochester
Twitter: @ehsan_hoque
Negotiation

Prediction of Interview Performance

Collaboration Coach

Training for oncologists

Music Training

Measuring credibility

Storytelling

Diagnosis of Parkinson’s

Public Speaking
Simulating cyber attacks in the Cloud

Simulation results
The shortest paths an attacker can use to compromise assets of value

AWS config data & vuln scan
AWS model
Attack graph
Shortest paths
Mitigations

The easiest way for an attacker to reach the most valuable assets
Organic Photonics and Nanooptics group,
Laboratory of Organic Electronics, Linköping University, Sweden
Augmented Reality meets Internet of Things

Dr. George Koutitas
Assist. Prof. Director at XReality Lab, coFounder Augmented Training Systems Inc., george.koutitas@txstate.edu

Vision: Integrate Internet of Things (IoT) with Augmented Reality (AR) and overlay IoT data on top of the physical world to create a 4D experience for the user.

Research Topics
• AR/VR Training for First Responders
• Resource allocation for AR applications (object detection)
• In situ visualization of wireless channels
• Network topology and protocol visualization

Figure 1. Network topology visualization for ZigBee
Figure 2. Channel strength visualization using AR
Formal Synthesis for Robotics
Hadas Kress-Gazit
Mechanical and Aerospace Engineering, Cornell University

\[ \psi_i = \neg (R_3 \lor O_1) \]
\[ \psi_t = \Box \neg (R_3 \lor O_1) \]
\[ \psi_g = \Box \Diamond R_1 \land \Box \Diamond R_2 \]
Cyber security: Threat modeling, attack simulations, ethical hacking

Associate prof. Robert Lagerström, KTH Royal Institute of Technology

Russians penetrated U.S. voter systems, top U.S. official says

The U.S. official in charge of protecting American elections from hacking says the Russians successfully penetrated the voter registration rolls of several U.S. states prior to the 2016 presidential election.

In an exclusive interview with NBC News, Joanne Marietta, the head of cybersecurity at the Department of Homeland Security, said she couldn't talk about classified information publicly, but in 2016, "We saw a targeting of 21 states and an exceptionally small number of them were actually successfully targeted."
SPECTRUM COLLABORATION CHALLENGE

OPEN COMPETITION
WIRELESS NETWORKS
SPECTRUM SHARING

NO
PLANNING
COMMUNICATION INFRASTRUCTURE
STANDARDISED RADIO TECHNOLOGIES

INTELLIGENCE
LEARN TO ADAPT

Team 1
Team 2
Team 3
Team 4
Team 5

Incumbent

Steven Latré

Email questions to sc2@darpa.mil

Distribution A. Approved for public release

Match Overview

48
Incumbent
Team 1 ... environment emulated in real-time:
• Large-scale path loss
• Multipath & Doppler
• Channel correlation
• Motion
SCATTER SOLUTION

OPTIMIZE DIFFERENT PROBLEMS ON DIFFERENT INTELLIGENT LAYERS

Gain adaptation

MCS adaptation

Slot selection

Link optimisation

Overall flow optimisation

Data scheduling

Flow prioritisation

Flow selection

1. YouTube
2. Chat
3. Police
4. Facebook Live

1. Police
2. Chat
3. YouTube
4. Facebook Live
Erin MacDonald
Assistant Professor of Mechanical Engineering
Design Group
Faculty Director of MS Design Impact Program
Stanford University

Sustainability

- Social
- Environmental
- Economic

Models of Stakeholders’ Decisions

Construction of Preference

Quantified Cognitive Empathy

Test vs. Control Experiments

Optimization

Complex Human Decisions (Sustainability)

Interviews, Observations, Surveying

IRIS Design Lab
Stanford University
Recipes, a black box and Edisonian approaches are not sustainable:

LAWRENCE LIVERMORE NATIONAL LABORATORY
U.S. Department of Energy lab located in California working in applied sciences for national security missions

OUR VISION
Be the foremost national security laboratory, anticipating, innovating and delivering solutions for the nation’s most challenging security problems.

OUR MISSION
To strengthen the United States’ security through development and application of world-class science and technology
**Our group aims to** accelerate certification and qualification of additively manufactured metals through focused experimentation, modeling and process development:

**Lawrence Livermore National Laboratory**

U.S. Department of Energy lab located in California working in **applied sciences** for national security missions

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**Our Mission**

To strengthen the United States’ security through development and application of world-class science and technology

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**Manyalibo “Ibo” Matthews**

Physicist, Group Leader
Laser-Material Interaction Science & Accelerated Certification of Additively Manufactured Metals

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**Lawrence Livermore National Laboratory**

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**Our group aims to** accelerate certification and qualification of additively manufactured metals through focused experimentation, modeling and process development:

**Understand physics and model validation**

- In situ absorptivity
- In situ optical imaging
- In situ X-ray probes

**Developing novel & model-based methods**

- Intelligent feed-forward
- Energy-alloy co-design
- High throughput printing

**Process monitoring of full scale builds**

- High speed
- Melt pool imaging
- Optical coherence tomography

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Prepared by LLNL under Contract DE-AC52-07NA27344.
Clean Air Toolbox for Cities

https://aqtoolbox.org @aqtoolbox

Contact PI: Prof. V. Faye McNeill
Columbia University, New York, NY, USA 10027
vfm2103@columbia.edu +1 (212) 854-2869
Research at the Chair “Technologies and Management of Digital Transformation”

- **Industrial Transfer Learning**
  - Learning without forgetting
  - Simulation to reality transfer

- **Industrial Natural Language Processing and Information Extraction**
  - Analyzing unstructured data

- **Semantic Data Management**
  - Knowledge graphs, ontologies and semantic models

- **Applied Artificial Intelligence in Industry**
  - Integration, start-up and condition monitoring

- **Explainable and Interpretable AI**
  - Ablations for transparent artificial neural networks

- **Industrial Sensory Data Analysis**
  - Classification, signal forecasting, anomaly detection, soft sensors
Design and development of Intelligent Sensing and Perception systems aimed at improving the quality of life in any physical environment

Application Fields:
- Diagnostics
- Service and Field Robots
- Robotic Networks
- Surveillance

MAIN RESEARCH PROJECTS
- ATLAS - H2020 (Grant No. 857125)
- E-SHELF - POR Puglia FESR-FSE 2014-2020 (Id. OSW3NO1)
- BESIDE - POR Puglia FESR-FSE 2014-2020 (Id. YJTGRA7)
- OK INSAID - ARS01 Progetti di ricerca industriale e sviluppo sperimentale area di specializzazione "Fabbrica Intelligente", PNR 2015-2020
- DITECO – PON Ricerca e Competitività 2007/2013

Advanced multi-sensor perception systems are developed for ambient awareness of robotic vehicles

Diagnostics: High resolution systems are used to inspect materials for quality control in order to check the production process and prevent damages in the final products.

Surveillance: Smart cameras are used for surveillance and security issues such as: observing people behaviors to improve the quality of life or to detect anomalous actions; analyzing the interactions between people and machines in all the contexts where technologies can support the human operators.

Sensor and robot networks are used to develop cooperative perception strategies.
Building Reliable Software as a Team

Marcus Mottare
Volvo Group Connected Solutions

Micro Service
Cloud Based
DevOps
Energy Internet and Cyber-physical Systems Group

- Objective: Use strong theory to solve practical problems via CPS
- Research line 1: IoT-enabled energy internet via packetized management
- Research line 2: Communication theory and machine-type communications
- Research line 3: Industrial Cyber-physical systems for rare event detection
- Projects:
  - Research Fellow EnergyNet (5y, 9.2019);
  - CHIST-ERA: Framework for the Identification of Rare Events via MAchine learning and IoT Networks (3y, 5.2019) << poster
- Group members: 1 master and 5 doctoral students, 1 postdoc and myself
- Strong international collaboration
Through partnerships we target to eliminate 30% of total Swedish greenhouse gas emissions

Swedish industry’s CO$_2$ e emissions (2017)

1. Joint venture for a fossil-free steel industry
   - Iron- and steel
   - Minerals (cement)
   - Refineries
   - Chemistry
   - Pulp and paper
   - Other metals
   - Food
   - Other

2. Electrified cement production

3. Fossil-free diesel production

Project CO$_2$ e reduction potential

1. 10%
2. 5%
3. 5%+15%*

*) Including reduction in transport sector
**Ylva Olofsson**  
System Design Engineer

**Battery 2nd life**
- Learnings from Volvo first pilot installation
- Economical and environmental aspects of battery reuse

- In collaboration with:  
  Riksbyggen, Göteborg Energi and Johanneberg Science Park
Second life of bus batteries

- Peak power reduction
- Local energy storage
- Buy and sell electricity

Pilot in Brf Viva 132 apartments, Göteborg

Battery installation 2018
Evaluation during 2019-2023
THE INTERNET OF PEOPLE
A HUMAN AND DATA-CENTRIC PARADIGM FOR THE NEXT GENERATION INTERNET

Trends impacting on Next Generation Internet (NGI)

- Internet expansion at the edge
  Lots of edge devices, with a lot of capabilities

- NGI: a data-centric network
  Main users’ interest in accessing/sharing content

- Cyber-Physical convergence
  Blurring between physical and cyber world

NGI as a human-centric Network: The Internet of People

- Edge devices typically owned by humans or “in touch with them”
  Smartphones, tablets, IoT devices

- Humans generate/access large share of edge data

CONTROL OVER PHYSICAL PROPERTIES IN AN ATOMICALLY THIN SEMICONDUCTOR

MICHAEL T. PETTES, PH.D.
SCIENTIST, MPA-CINT
LOS ALAMOS NATIONAL LABORATORY

UNCOVERING UNSEEN FUNCTIONALITY AND EMERGENT PHENOMENA INHERENT TO NANOMATERIALS AND PROMISING FOR QUANTUM INFORMATION SCIENCE, NANOELECTRONICS, SENSORS, AND ENERGY CONVERSION APPLICATIONS THROUGH INNOVATIVE EXPERIMENTAL TECHNIQUES.
Machine Learning for Communications
- How can machine learning techniques be exploited for wireless communications?
- Use case 1: Data analytics
- Use case 2: Autonomous optimization with (deep) reinforcement learning
- Rich application domains

Communications for Machine Learning
- Can we design wireless systems that can reliably support emerging ML paradigms?
- Case in Point: Federated learning
- How can we integrate FL over 5G?
- Reliability and latency guarantees to perform edge FL

More information: http://www.netsciwis.com
RadioSense
Opportunistic sensing and perception through ambient radio signals

Challenges:
1. Wireless networks transform into a dense web of RF-imaging links

2. Opportunistic sensing through the transformation of ambient RF into sensing modalities

3. do not require the target to be instrumented or collaborative

Application scenarios
(see poster session):

1. Collaborative robotics (robot-assisted manufacturing)

2. Smart home, assisted living (WiFi radar)
Vulnerable road user protection

Enablers:

- Highly accurate 5G radio-based localization of road users with compensation of multipath propagation
- Resource efficiency through lightweight protocol architecture
- Low-complex trajectory estimation and map matching with motion models for vehicles and pedestrians
- Ultra reliable prediction of collisions with near-zero false alarm rate
- Low latency transmission of warning messages from mobile edge cloud to road users
Digital Twins in robotics

- Digital Twins are virtual replica of physical assets,
- which can simulate, control and monitor technical systems,
- for the design, programming, commissioning, operation, monitoring and optimization of technical systems,
- including product, production system and production environment,
- with techniques such as:
  - hybrid online/offline simulation and visual programming
  - human-robot interaction with virtual humans
  - large-scale/long-term databases
  - sampling-based motion planning
Layer-by-Layer (LbL) Optical Coatings

Thin, conformal coatings with diverse functionality. Focus on optical coatings and films – enhancing existing products and enabling new products.

- Retroreflective signage and fabrics
- Angular light control / privacy filters
- OLEDs and QD Displays

Roll-to-roll processing

Reduced color shift in OLED displays, protection of QDs in QD/LCD displays

Co-localized color and retroreflection, higher brightness
A Systems Approach to Sustainability Analysis: Examples from Mercury Pollution

Noelle E. Selin, Massachusetts Institute of Technology

Are you interested in analyzing systems that are relevant to human well-being, today and in the future?

Check out our new matrix-based framework that can help you analyze systems with technical, human, environmental, institutional, and knowledge components.

And see how the framework works through the example of mercury pollution.

Or just come to learn some odd fun facts about Hg: what do mercury and human waste have to do with American history? Find out at the poster…

Based on a forthcoming book by H. Selin & N. E. Selin, forthcoming
Fall 2020 with MIT Press

Graphics from SLU, Uppsala
AI and IA for automated microscopy

Ida-Maria Sintorn
Dept. Information Technology
Uppsala University
Vironova AB
Massive amounts of data calls for smart automation strategies

The size of an Adenovirus

by Gustaf Kylberg

\[ \phi = \sim 3 \text{mm} \]

pixelsize 0.5nm

1 byte per pixel

\[ \Rightarrow 29 \text{TB image data} \]

FOR ONE SAMPLE if blindly scanned
See an Atom, Know an Atom, Move an Atom: Materials Imaging, Spectroscopy, and Modification at the Single-Atom Scale with Electron Microscopy

Nature gives us stochastic atomic motion and defect distribution.

Aberration-corrected STEM enables single-atom sensitivity characterization and control for next-generation device development.

Rhonda Stroud
Head, Nanoscale Materials Section

Distribution A: Approved for public release. Distribution is unlimited.
TRL 7

Operates 24/7
Weights 150 kg (800x1000x350 mm)
Visual inspection and cold-spray
Climb vertical and walk across 2 cm steps
Dry & wet applications
Use cases in turbogas, oil&gas & water pipelines
Zero-Emission Power Generation using Direct-fired Supercritical CO\textsubscript{2} (sCO\textsubscript{2})

Burn Fuels in CO\textsubscript{2} instead of air for electricity
Fuel + O\textsubscript{2} \rightarrow CO\textsubscript{2} + H\textsubscript{2}O

Impact:
• Low Cost Power
• Near-zero Emissions- zero NOx and CO\textsubscript{2}
• High Efficiency
• Small Equipment Size
Imaging Understanding

Enabling

- nucleation, growth & transformations of nanoscale materials, especially those outside equilibrium
- solid-liquid (including electrode-electrolyte) interfaces

novel materials engineering and device development

Through developing and applying in situ transmission electron microscopy techniques

Haimei Zheng
Senior Staff Scientist, Lawrence Berkeley National Laboratory & Adjunct Professor, University of California, Berkeley

Real Time Imaging of Materials Transformations Using In Situ Transmission Electron Microscopy