Graduate Studies in Engineering and Computer Science
at the
University of Central Florida

Department of
Electrical and Computer Engineering

College of Engineering and Computer Science

UCF

UNIVERSITY OF CENTRAL FLORIDA

Department of
Electrical and Computer Engineering (ECE)

Faculty and Students	Research Faculty	Lecturers	Doctoral Students	Master Students
Fall 2017	33	6	167	108

Research Areas in Elec Eng.
- Communications
- Digital signal & image processing
- Controls and robotics
- Electromagnetics
- Electro-optics and photonics
- Power and energy systems
- Solid-state microelectronics

Research Areas in Computer Eng.
- Systems and reconfigurable devices
- Sensor networks and smart sensors
- Software engineering
- Intelligent systems and machine learning
- Computer networks

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Fall 2017 Enrollment

Graduate Enrollment	PhD	MS
Electrical Engineering	123	62
Computer Engineering	44	46

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❑ Cyber-Physical Systems

Research disciplines:
- ➤ Communication
- ➤ Control, Optimization, and Systems Theory
- ➤ Signal Processing
- ➤ Power and Energy Systems

Faculty members:

George Atia, Aman Behal, Aleksandar Dimitrovski, Yaser Fallah, Michael Georgiopoulos, Michael Haralambous, Qifeng Li, Wasfy Mikhael, Junjian Qi, Zhihua Qu, Nazanin Rahnavard, Marwan Simaan, Wei Sun, Azadeh Vosoughi, Art Weeks, Lei Wei, Qun Zhou

❑ Micro-systems and Nano-systems

Research disciplines:
- ➢ Semiconductor Devices
- ➢ MEMS
- ➢ Bio-Sensors
- ➢ Power Devices and Electronics

Faculty members:

Reza Abdolvand, Issa Batarseh, Brian Kim, Don Malocha (courtesy), Kalpathy Sundaram, Peter Yuan

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❑ Electromagnetics and Remote Sensing

Research disciplines:
➢ Antenna
➢ RF sensors
➢ EM
➢ Remote sensing

Faculty members:
Xun Gong, Linwood Jones, Parveen Wahid, Thomas Wu

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❑ Research Highlights

Centers nationally-competitively-awarded to ECE:

➢ FEEDER center on smart grids (Department of Energy)
➢ MIST center on integrated devices (National Science Foundation)
➢ EVTC center on electric vehicles, jointly with FSEC and CECS (US Department of Transportation)

Samples of funded projects:

➢ Smart grids (NSF, DoE, industry)
➢ Wireless sensors (DoD, NASA, industry)
➢ Remote sensing (NASA)
➢ Phased antenna arrays (DARPA, DoD, NSF, industry)
➢ High performance and data-intensive computing (NSF)
➢ Brain research (NSF)
➢ Wireless communication and sensor networks (NSF)

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Electrical and Computer Engineering

CMOS-based Massive-throughput Biosensors
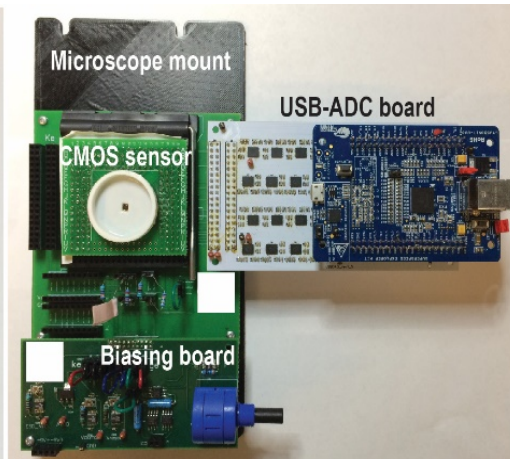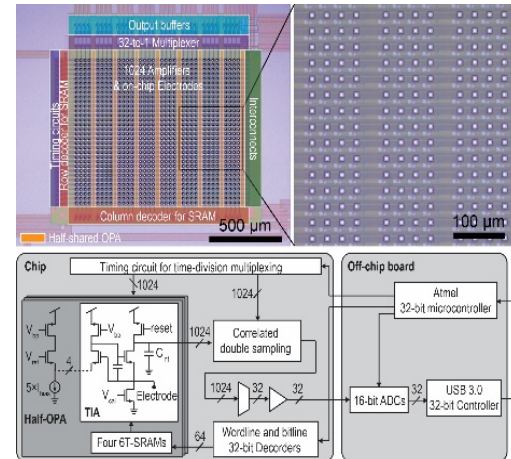
Nano-engineered Si-based thermoelectric IR sensors

An array of IR sensors for imaging

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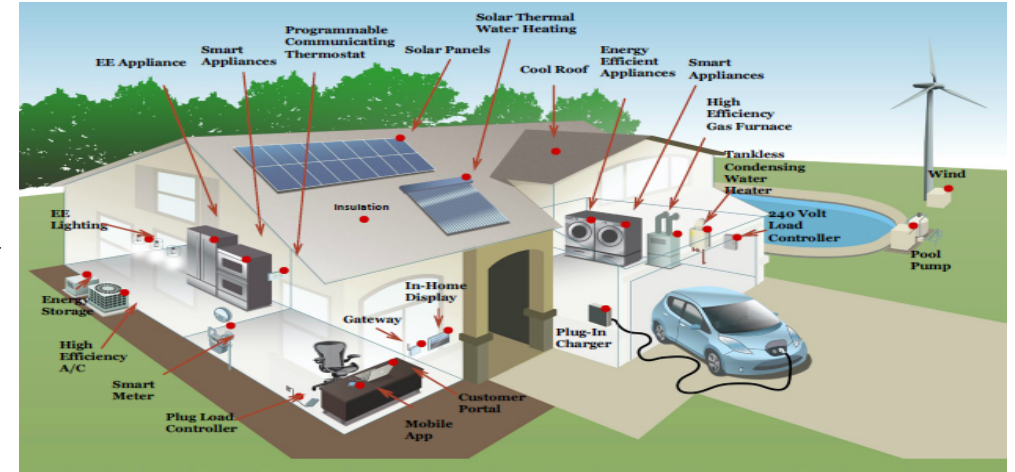
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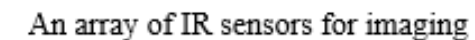
Electrical and Computer Engineering

Autonomous Ground vehicles

Path planning and autonomous control interface developed by UCF for US Army

Smart Grid – Plug & Play & Intelligent

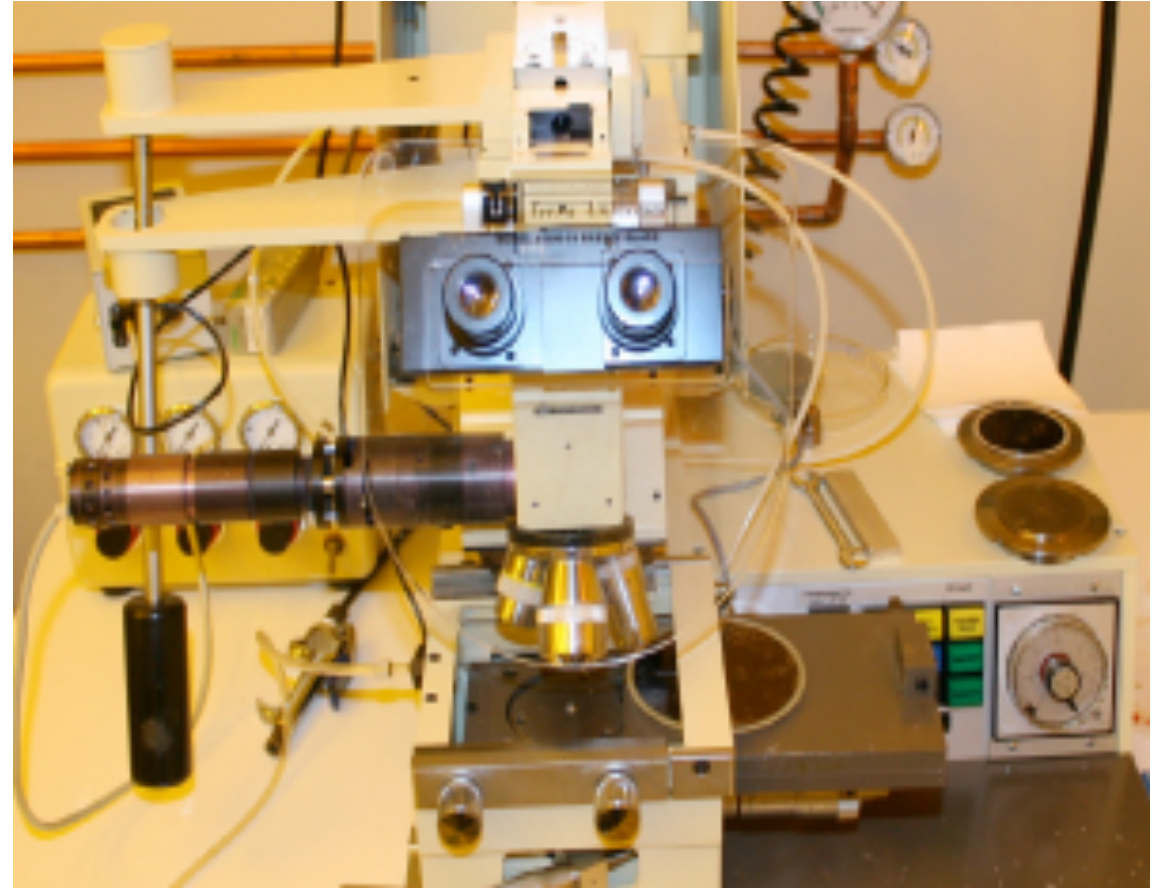**Teleoperation and Medical Robotics**

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Electrical and Computer Engineering

Microfabrication Cleanroom Facility

Mask Aligner

College of Engineering
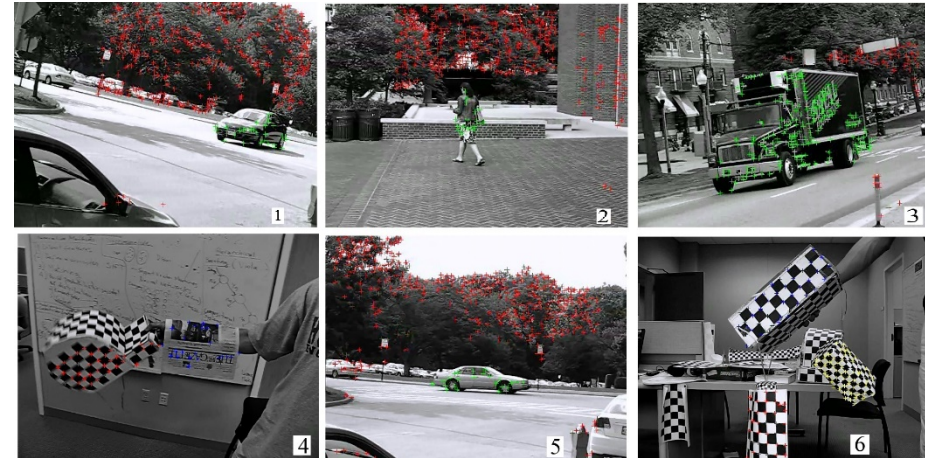and Computer Science
UNIVERSITY OF CENTRAL FLORIDA

George Atia Research: Big Data Analytics

Low rank + sparse decomposition

- Activity detection and background subtraction
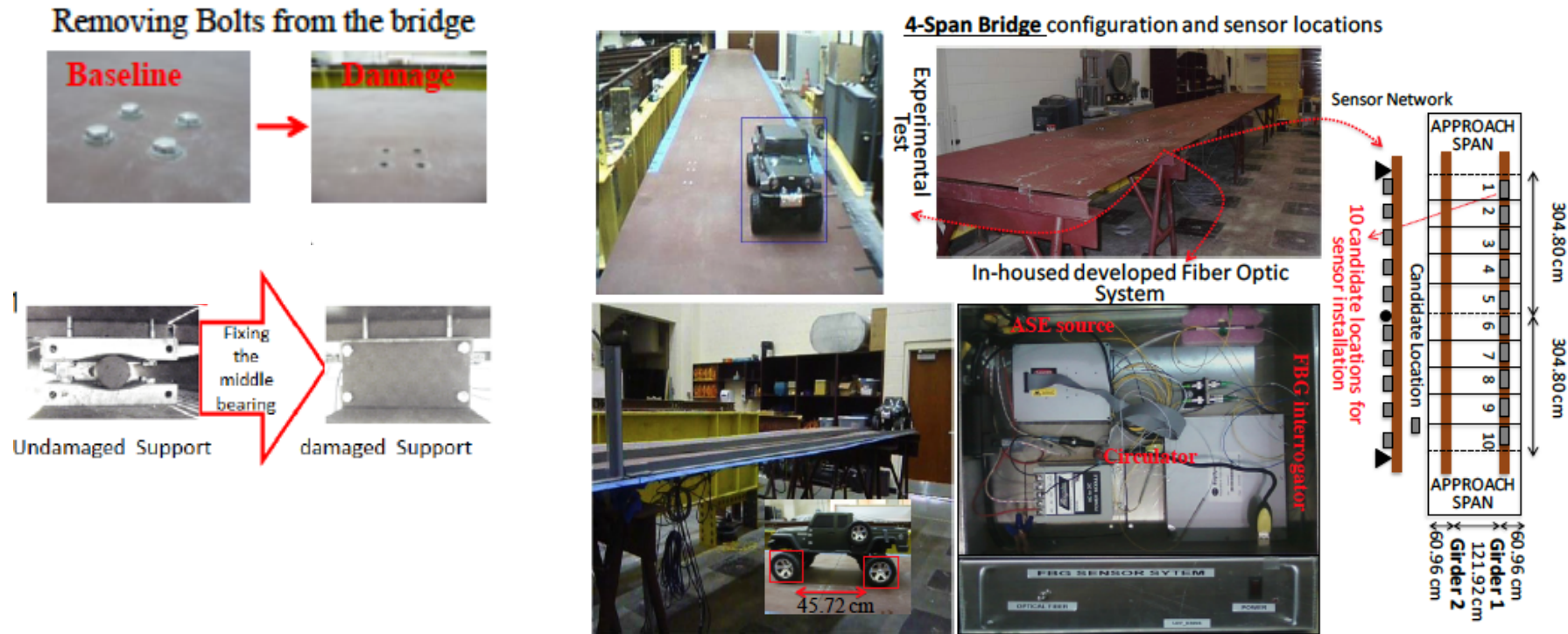- Video summarization
- Video segmentation

Inference driven data processing and acquisition: scalability, robustness and control, **NSF CAREER Award**, Feb 2016.

Subspace clustering

➢ Speedups: Often 5000x faster than state-of-the art -- low dim learning in reduced data sketches
➢ Fundamental limits and provable algorithms

George Atia Research: Structural Health Monitoring

Removing Bolts from the bridge

Baseline → Damage

Fixing the middle bearing

Undamaged Support → damaged Support

4-Span Bridge configuration and sensor locations

Experimental Test

In-housed developed Fiber Optic System

ASE source

Circulator

FBG Interrogator

45.72 cm

Sensor Network

10 candidate locations for sensor installation

APPROACH SPAN

Candidate Location

APPROACH SPAN

304.80 cm

304.80 cm

60.96 cm

Girder 1

121.92 cm

Girder 2

60.96 cm

Structures Laboratory at UCF (CECE)

- Localization of sparse changes (role of sparsity, scaling laws, compression gains)
- Change detection from compressive measurements

[Atia, Catbas, J. of Civil SHM 2015] (Collaboration with CECE)

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Jun Wang Research:
Big Data Movement from Myriad Sources
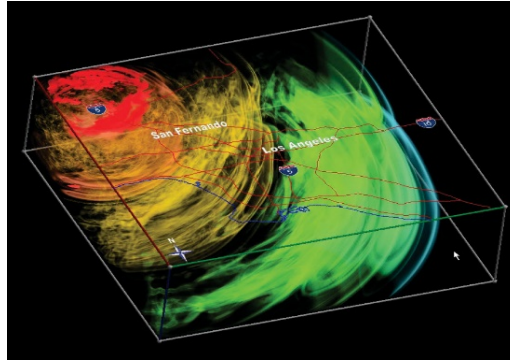
Data from Scientific Simulations

Data from Internet of Things

Data from Satellites

Data from Social Networks

Explosive growth of scientific information and simulation data.

Suffering from I/O interference in moving **"big data"** from multiple sources to the network/parallel file system.
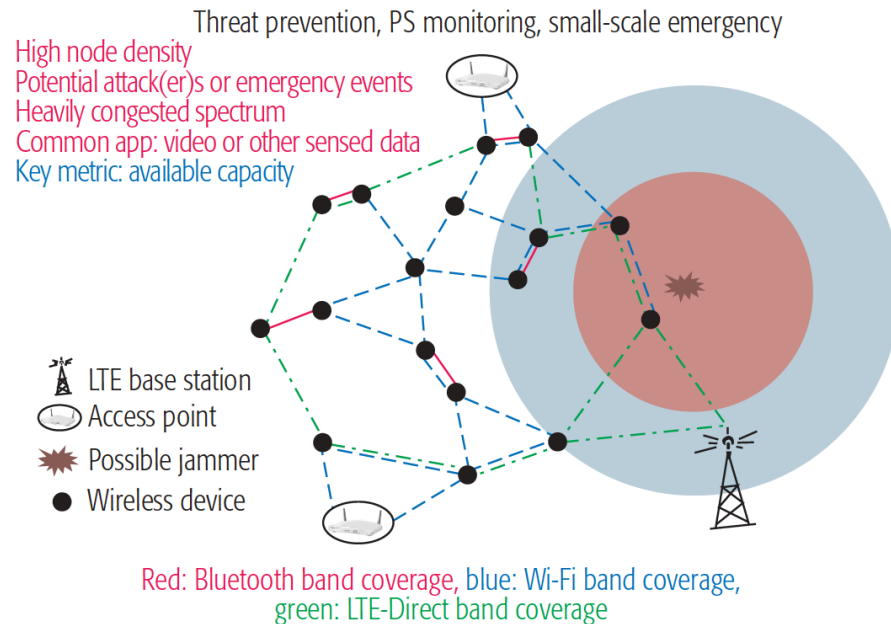
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Jun Wang Research: Managing and Isolating Big Data Movement via Our Software Defined Lightweight Virtualization Techniques

Data Providers

Virtualization Layer

Shared Storage

Google Cloud Platform +
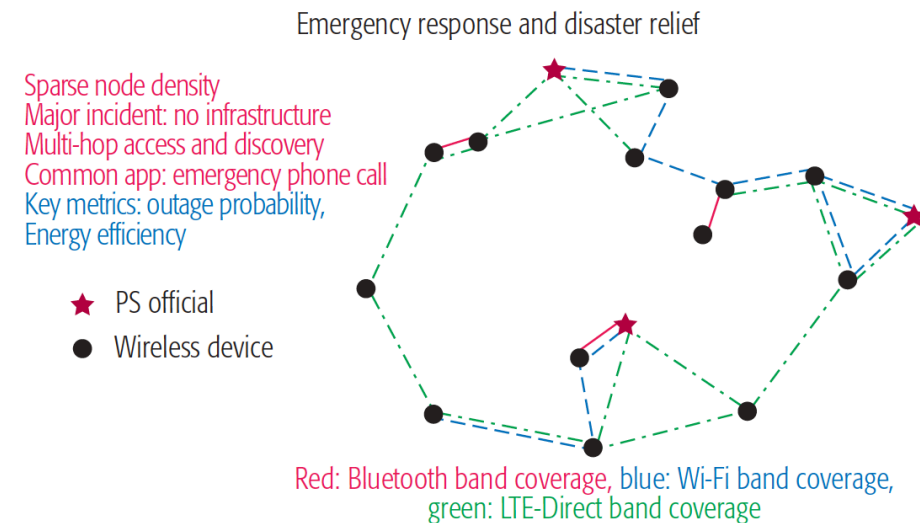HADOOP
MANAGED SERVICES

- Virtualization technique is widely deployed for elastic resource provisioning.

- Data streams are coordinated by software defined virtual devices e.g. virtual switch and container.

Murat Yuksel Research: Pervasive Spectrum Sharing for Public Safety Communications (NSF EARS ~$700K)

Threat prevention, PS monitoring, small-scale emergency

High node density
Potential attack(er)s or emergency events
Heavily congested spectrum
Common app: video or other sensed data
Key metric: available capacity

LTE base station
Access point
Possible jammer
Wireless device

Red: Bluetooth band coverage, blue: Wi-Fi band coverage,
green: LTE-Direct band coverage

Challenges: How do we form the multi-band topology? Which bands do we use? How do we schedule the users considering their fairness and QoS constraints to achieve best capacity?

Scarce capacity

Emergency response and disaster relief

Sparse node density
Major incident: no infrastructure
Multi-hop access and discovery
Common app: emergency phone call
Key metrics: outage probability,
Energy efficiency

PS official
Wireless device

Red: Bluetooth band coverage, blue: Wi-Fi band coverage,
green: LTE-Direct band coverage

Challenges: How do we form the multi-band topology to minimize the outage? How do we schedule the users considering their power constraints?

Scarce power

Google "pervasive spectrum sharing"

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IEEE COMMAG 2016
Risk Hazards & Ciris in Public Policy 2016
J. of Emergency Management 2016
IEEE LANMAN 2016

Murat Yuksel Research: US Ignite: Rapid and Resilient Critical Data Sourcing for Public Safety and Emergency Response (NSF $600K)

Idea: Use device-to-device (D2D) communications, cloud computing and GENI slices for crowdsourcing and real-time processing of critical data
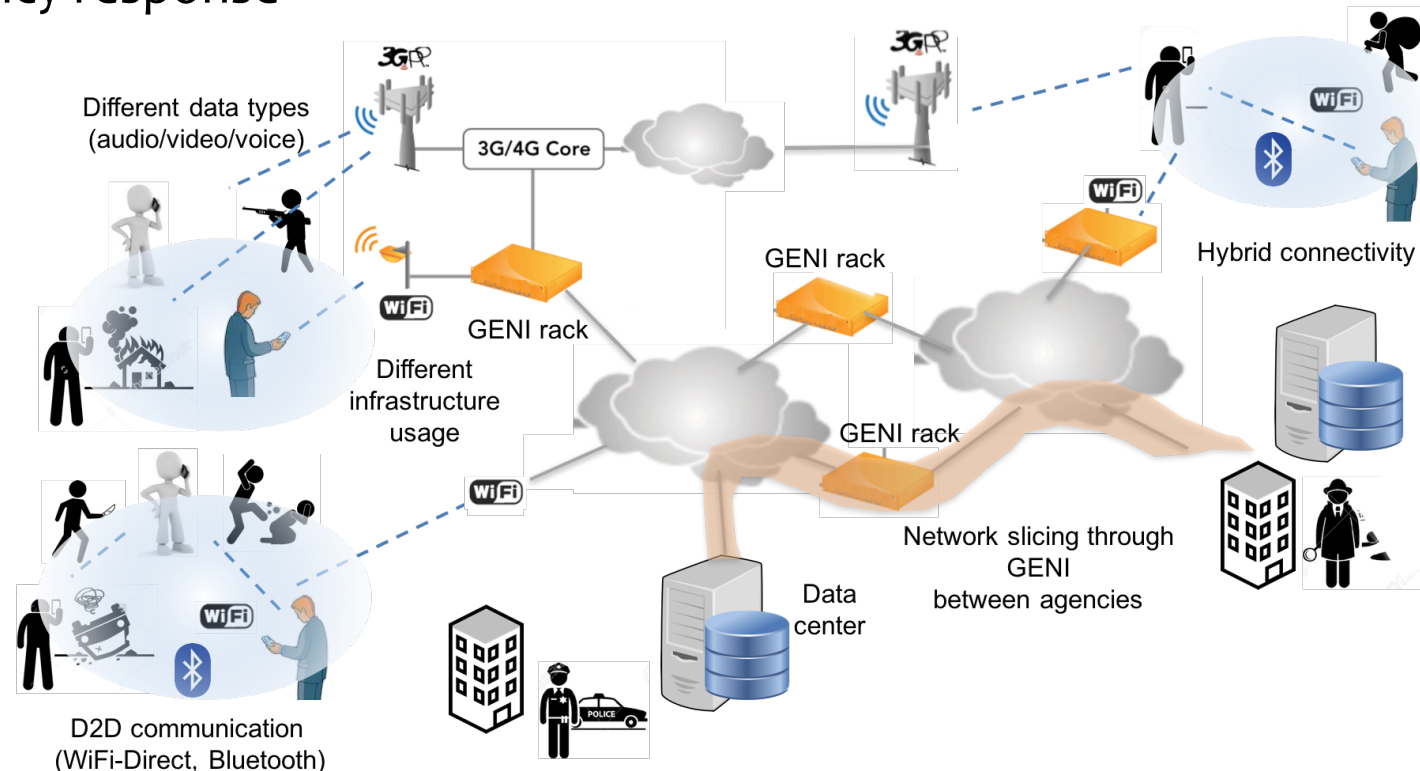
Applications in:

- Public safety monitoring
- Emergency response

Team:

VCU: Bulut & Manic

- D2D routing
- GENI setups

UCF: Yuksel & Turgut

- Wireless GENI augmentation
- D2D communication
- User privacy

Zhihua Qu, Professor & Chair of ECE

***Cooperative Control and Distributed Optimization of Cyber-Physical-Human Systems***

Research focus (current/past funding agencies):
- Cooperative control & distributed optimization (NSF/L-3/LM)
  - Cooperative guidance for multiple munition
  - Cooperative control of UAVs, UGVs and UUVs
- Nonlinear controls (NSF, DoD, Coleman Aerospace)
  - Analytical 6-dof nonlinear autopilot design for missiles
  - Robust and nonlinear optimal controls
- Game-theoretical controls and optimization (NSF)
- Plug-&-play operation of heterogeneous networked systems (NSF, DoE, DoT, Harris, Leidos)
  - Autonomous vehicles
  - Smart grids
- Secure cyber-physical-human systems (DHS, DoE, TI, Leidos)
  - Resilience of large scale infrastructure systems
  - Distributed state estimation for attack detection
  - Resilient networked control
  - Optimization of physical and communication networks

Applications and impact:
(1) Teleoperation: aerial refueling of UAV, etc.

(2) Formation control, coverage control: UAV wingman, etc.

(3) Missile guidance, simultaneous strikes of targets, etc.

Yaser Fallah Research: Model Based Communication and Control (NSF CAREER)

□ Scalability solution transformed to the concept of

"Model-Based Communication and Control"

□ Modeling of Connected and Automated Vehicles dynamics using "Stochastic Hybrid Systems"

□ Application: Cooperative Adaptive Cruise Control
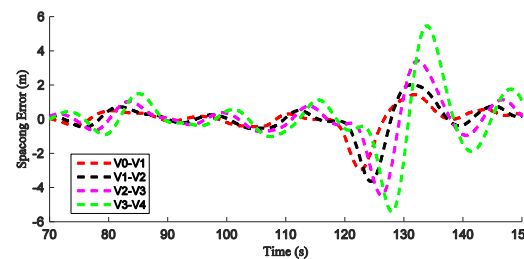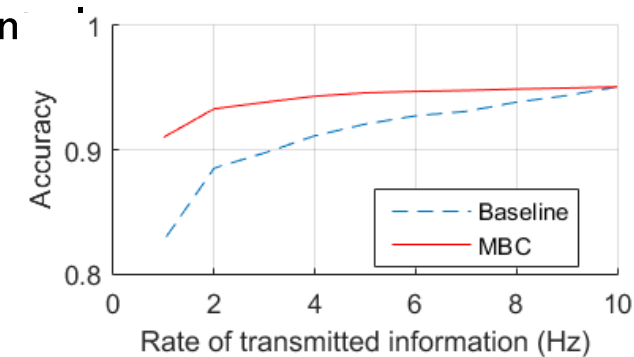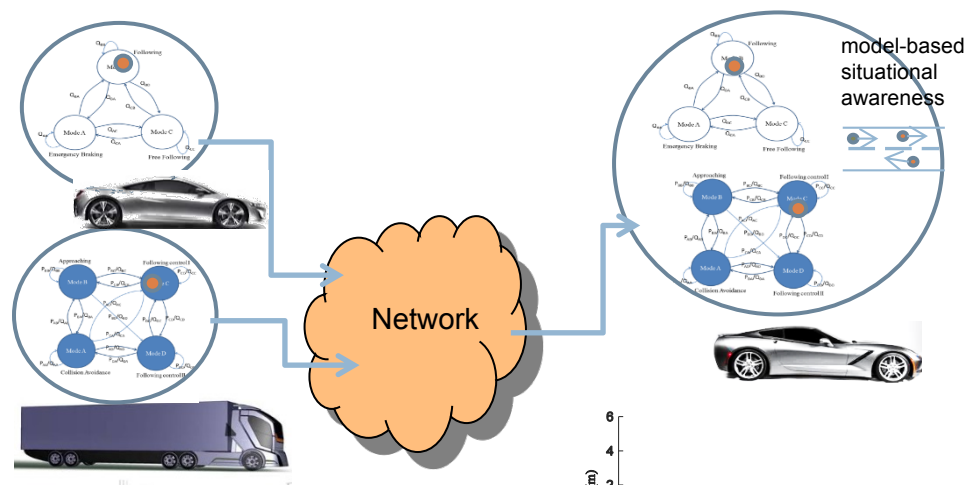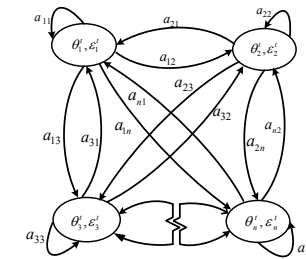
conventional CACC   MBC CACC
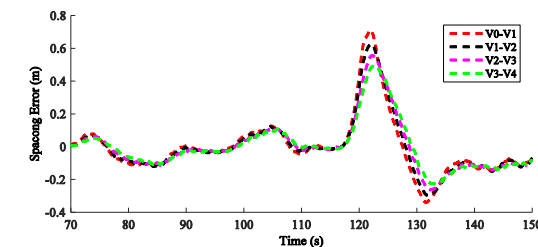
George Atia
Faculty, CECS

Azadeh Vosoughi
Faculty, CECS

Stephen Berman
Faculty, COM

Alan Paris
PhD student, IST

**First federally-funded project between CECS and COM**

NSF: *Advanced Ion Channel Models for Neurological Signal Processing – Theory and Application to Brain-Computer Interfacing*, Awarded Sept 2015, George Atia, Azadeh Vosoughi, Stephen Berman, $185,000.

Brain computer interfacing (BCI)

Situational awareness

*Control and communication
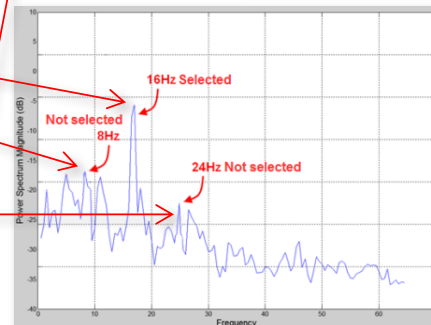for brain-injured, quadriplegic patients*
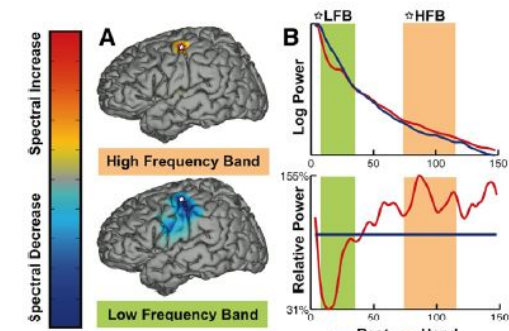
*Seizure source localization
and functional brain mapping*

Steady-State Visual Evoked Potential (SSVEP) BCIs
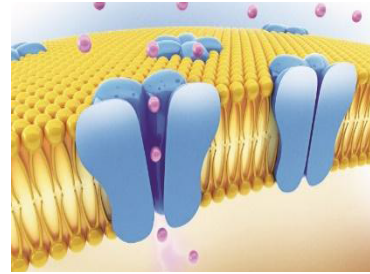
Signal
Processing
of the EEG

*1. Lights are flashed at several frequencies
either on a screen or on an LED-based device.*

*2. The subject makes selections simply by focusing
his attention on a particular flashing area.*

*3. The selected frequency then shows up in the brain's
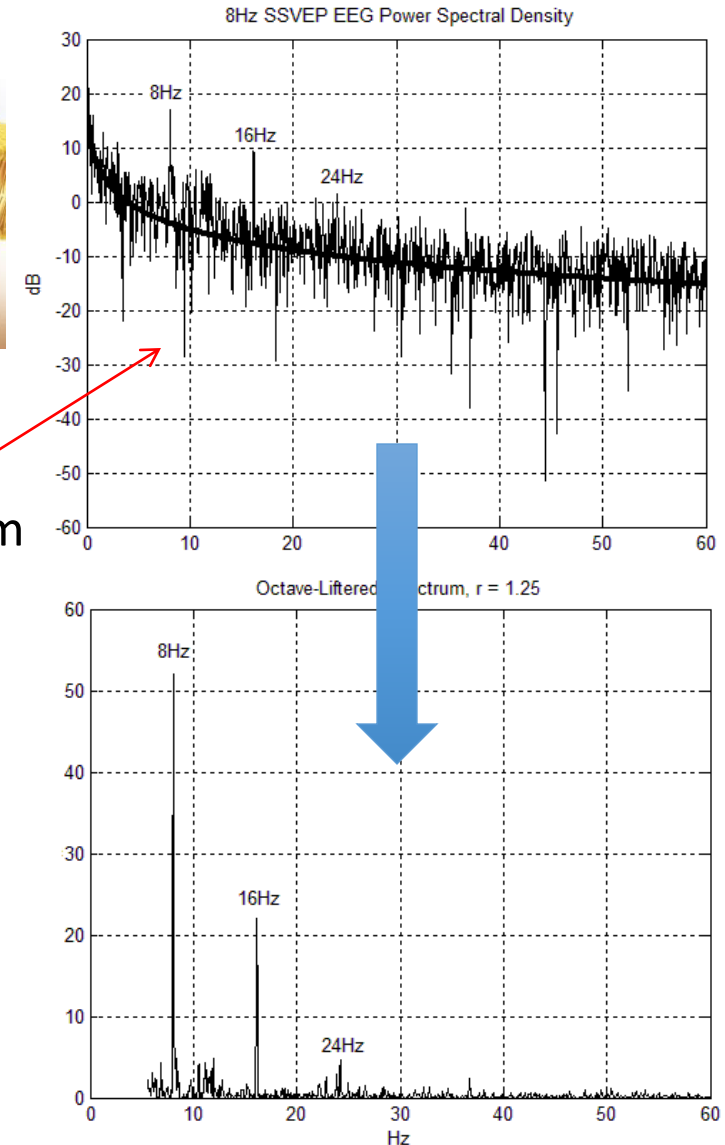EEG response and can be used as a control signal.*

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BCI uses brain signals to control systems

but brain tissue is **very noisy** because of random chemical kinetics

8Hz SSVEP EEG Power Spectral Density

Octave-Liftered Spectrum, r = 1.25

- We are developing new **quantum-thermodynamic** stochastic models of neuronal tissue to parameterize its noise characteristics
- and non-linear signal processing methods to render this noise **transparent**.

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➢ Problem: Classifying motor imagery brain signals (imagined movement of limbs)

➢ Goal: Use less data and efficient algorithms to support real-time BCI.

➢ Approach:

  o Exploit sparse characteristics of EEGs.

  o Energies in different frequency sub-bands of the Wavelet Packet decomposition of EEG trials from few electrodes near the sensorimotor cortex.

Left hand movement

Right hand movement
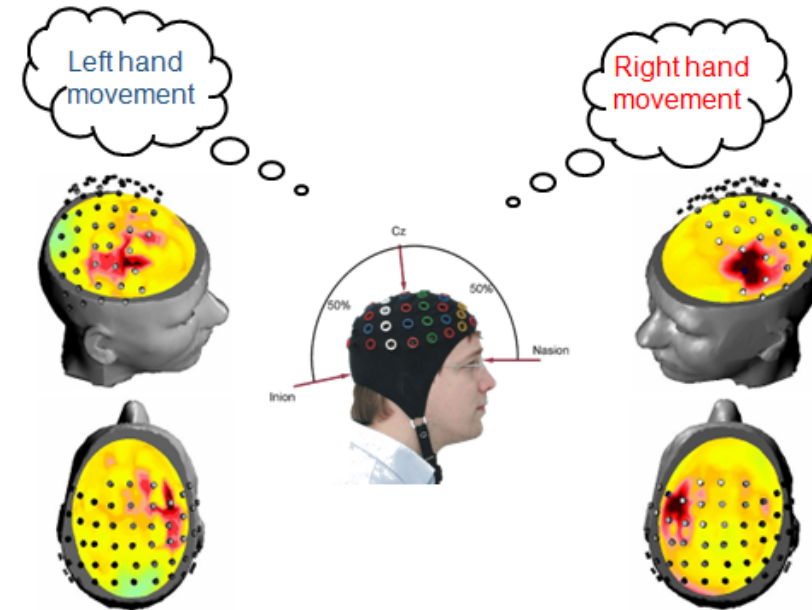
Pouria Saidi, George Atia, Alan Paris and Azadeh Vosoughi, GlobalSIP 2015.

M.Sc. Thesis, Pouria Saidi, Motor Imagery Classification using Sparse Representation of EEG signals, 2015. (Committee: G. Atia, A. Vosoughi, S. Berman)

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❑ **Companies that hire ECE Graduate Students**
- NASA
- Lockheed Martin
- Harris Corporation
- Intersil Corporation
- Siemens
- General Dynamics Corporation
- Qorvo
- Intel Corporation
- Global Foundries
- AMD
- Analog Devices Inc.
- Texas Instruments

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