An Overview of Research Areas of Microsystems & Computers
Dept. of Electrical & Computer Engineering

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Department Research Areas

**Controls & Laser Comm**
- V. Nikulin
- V. Skormin
- E. Wu

**Info Security**
- Y. Chen
- S. Craver
- J. Fridrich
- V. Skormin
- L. Guo
- M. Kirchner
- D. Summerville

**DSP & Comm**
- M. Fowler
- E. Li
- S. Zahorian

**Computer Design**
- Y. Chen
- Z. Jin
- D. Summerville

**Micro- & Opto-Electronics**
- S. Choi
- D. Klotzkin
- A. Rastogi

**Power & Energy**
- T. Dhakal
- A. Rostogi
- E. Wu
- Z. Zhang
- N. Zhou
Yu Chen: Intelligence Measure of Cognitive Radio Networks

(In Collaboration with Prof. Edward Li)

- **Goal:** to construct a CRN intelligence model from the Cattell-Horn-Carroll human intelligence model
  - Cognitive Radio Networks (CRNs)
    - In order to resolve the impending spectrum shortage problem
    - Achieve extremely high spectrum efficiency and guarantee the peaceful coexistence with legacy systems
  - Cognitive capabilities and intelligence are vital
    - They are necessary for optimizing spectrum efficiency and guaranteeing safe coexistence in the presence of the spectrum uncertainty
    - Their quantitative study is still largely an open area
  - **Task:** Collective IQ-based Denial-of-Service (DoS) attack immunity
    - Prompt anomaly detection using sequential (quickest) change-point detector
    - Adaptive spectrum assignment decision making engine
Yu Chen: Mission-Critical Urban Surveillance in Fog

- **Smart City: an Attractive Proposition**
  - The Internet makes the city **connected**
  - The Internet of Things (IoT) makes the city **sentient**
  - Situational awareness (SAW) makes the city **smart**
    - Efficient information abstraction
    - Instant decision making

- **Fog Computing vs. Cloud Computing**
  - Mission critical applications are latency sensitive
    - Cloud is far away, but Fog is on the ground

- **Main Challenges**
  - Addressing the gap between the large amount of dynamic data and limited computing resource available at the network edge
  - Enabling a homogeneous paradigm through “softwareisation” of hardware built at the edge of the networks
  - Supporting instant decision making by elastically orchestrating the tradeoffs between resource utility efficiency and Quality-of-Service requirements
My research group is interested in conducting research at the interface of engineering and biology. We engineer BioMEMS and microsystems to develop cutting-edge technologies for chemical/biological analysis and energy harvesting.
**BioMEMS**  
**BioSensors & BioEnergy**

### Biosensors
- **Cancer diagnostics**
- **Transducers**
  - Liquid droplet
  - Top electrode
  - Bottom electrode
- **Electronic noses**
- **Bio-separators**

### Bioenergy
- **Microbial fuel cells**
- **Photosynthetic Microbial fuel cells**
- **Microfluidics**
- **Studies on microbial electron transfer**
  - 24 hours
  - 48 hours
  - 72 hours
1. **Biological Solar Cells**: Designed a biological solar cell that’s a million times more effective than current technology. It was published in “Lab on a chip” journal as a front cover and reported by Materials 360 (MRS’s online publication), Solar Novus Today & Discover-e Newsletter.

2. **Paper-based Biobattery**: Designed a origami paper-based microbial fuel cell that can sustainable power disposable biomedical device in remote and resource-limited locations. This work has recently gained significant attention from the community and has been reported on in media outlets, including PBS NEWSHOUR, Time Warner Cable News, Newsweek, and Science Daily.

3. **48 well-MFC array**: Designed the most rapid and the highest throughput test platform for electrochemically active bacterial screening.

4. **Paper-based Electronic Nose**: A novel paper-based cantilever sensor array for simple and rapid naked-eye VOC detection without any power, electronics or read-out interface/equipment.
Klotzkin Research Areas

- Applied antireflection coatings
- Improved LED lighting
- Improved Solar Cell Efficiency

Surface coating for higher efficiency solar cell

Sphere-coated solid phosphor

AR Coating for LED lighting
Klotzkin Research Areas

- Semiconductor laser diodes, including
  - Quantum dot devices
- Modeling and analysis of distributed feedback lasers for higher yield and improved characteristics

Modeled/measured DFB laser spectra

Quantum dot laser characteristics
Klotzkin Research Areas

- Health care and miscellaneous, including
  - Monolithic Ca\(^{+}\) blood monitors
  - Investigation in LED operation after impact

\[ \Delta I_{\text{sat}} \text{ vs impact force on LEDs} \]
Thin Film & Hybrid Solar Cells Integrated with Supercapacitor Energy Storage

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**Thin Film and Organic Solar Cells using Nano-photo Absorbers in 3-D Configuration**

- Solar cells utilizing full solar spectrum
- Solar cells: low thermal budget & high energy payback

**Hybrid & Ferroelectric Interface Solar Cells**

- Low cost, flexible and green processes for solar cells

**Nanocomposite Solid-State Supercapacitors: A New Paradigm in Solar Electricity Storage**

- High energy density integrated storage of solar electricity
- Multifunctional supercapacitor nano-architecture

**Supercapacitor Storage Integrated Solar Module & Associated System Electronics**

- Power electronics for efficient solar electricity storage
- Optimum power delivery and monitoring electronics
Cyber-Med Lab – PI: Dr. Zhanpeng Jin

Smart and Connected Health

Cyber-Med Lab

Neuromorphic Computing

Novel Biometrics

“Brain on Chip”

PUBLIC CLOUD

PRIVATE CLOUD

CLOUD SERVICES

Patient Monitoring

Prescription Management

Medical Records

Watson Review

Binghamton University

STATE UNIVERSITY OF NEW YORK

Thomas J. Watson School of Engineering and Applied Science

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"Brainprints": a biometric securer than fingerprints

Brainprint: Your Mind's Reaction to Certain Words Could Be Your Password

WILL OUR "BRAINPRINTS" REPLACE THE NEED TO MEMORIZE PASSWORDS?

NEW RESEARCH REVEALS THAT THE WAY OUR BRAINS REACT TO CERTAIN WORDS MAY PROVE TO BE MORE UNIQUE AND THEFT-PROOF THAN OUR FINGERPRINTS.

BY LYDIA DISHMAN

A NEW KIND OF PASSWORD: BRAINPRINTS COULD BE THE FUTURE OF SECURITY

By Lulu Chang — June 8, 2015

Binghamton, NY — We all emit slightly different brain waves in response to stimuli, and researchers say that an individual's specific "brainprints" could be used to validate our identities. Christopher Intagliata reports.

By Christopher Intagliata | June 5, 2015
Goals:
- Trusted supply chain for FPGA or ASIC designs
- Allow use of COTS tools and IP
- Trust-preserving design techniques.

Accomplishments:
- Automatic implantation of low-impact covert HTHs
- Tool-independent generalized detection methodology without reference design

Objective: Ensure trusted ASIC/FPGA supply chain free of covert Trojans

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Ultra-Lightweight Anomaly Prevention for IoT Devices
--Douglas Summerville

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Objective: Strong intrusion prevention for insecure embedded IoT devices

Goals:
• Very small hardware footprint
• High-resolution attack detection
• Automatic deployment

Accomplishments:
• Lightweight anomaly detection with throughputs of 170k packets per second
• Low-area hardware and software implementation
• Integration with Xtables