COLUMBIA | ENGINEERING
The Fu Foundation School of Engineering and Applied Science

COLUMBIA UNIVERSITY
ELECTRICAL ENGINEERING

EE & CE GRADUATE STUDENT ORIENTATION

Prof. Gil Zussman

Department Vice Chair

Professor Ioannis (John) Kymissis

Department Chair

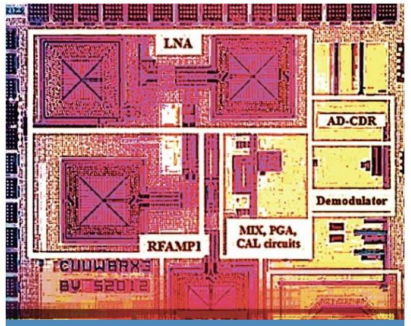
EE Faculty

Brief History of the Department

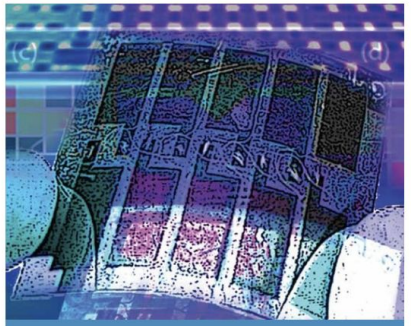
- Thomas Edison's suggestion – 1889
- Crocker and Pupin – long distance telephony
- Edwin Armstrong – feedback, heterodyne receiver, FM
- R. Schwartz, Ragazzini, Zadeh, Millman – control theory, electronics
- Kalman, Jury – sampled data systems
- M. Schwartz – telecommunications and computer networks (CTR)
- Anastassiou – MPEG-2 and DVDs

Research Areas

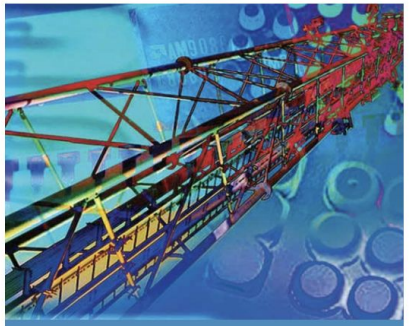
Computer Engineering and Computer Systems



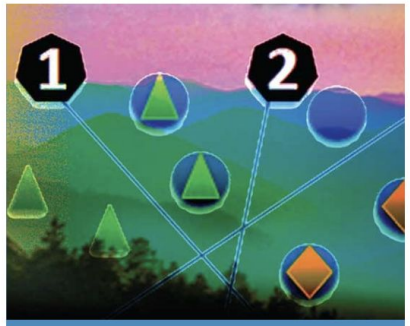
Integrated Circuits and Systems



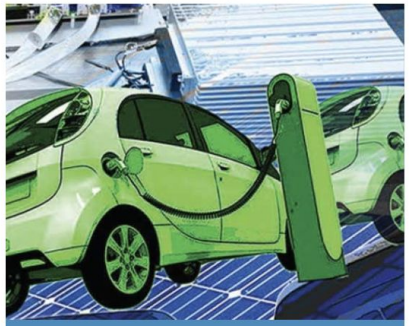
Nanoscale Structures and Integrated Devices



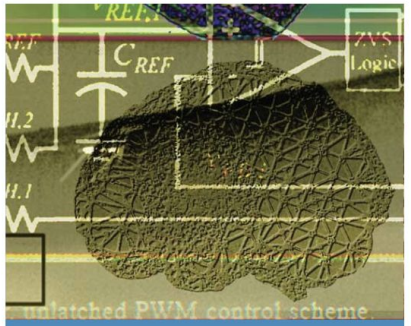
Networking and Communications



Signals, Information and Data



Smart Electric Energy



Systems Biology and Neuroengineering

Networking & Communications

- Field driven by challenges imposed by data communication for novel anywhere/anytime/any device applications and services
- Key areas
  - Next-gen, high-performance wired/wireless/cloud networks
  - Big-data, Internet-of-things, Ad-hoc devices
  - Data center networks, energy efficiency
  - Overlap with optical devices, energy
  - Peer-to-peer sensor networks, smart grid, cloud computing
  - Cybersecurity, with overlaps from computer science to circuits and physical principles, and crucial to Data Sciences
  - Connections to data sciences, industry collaborations
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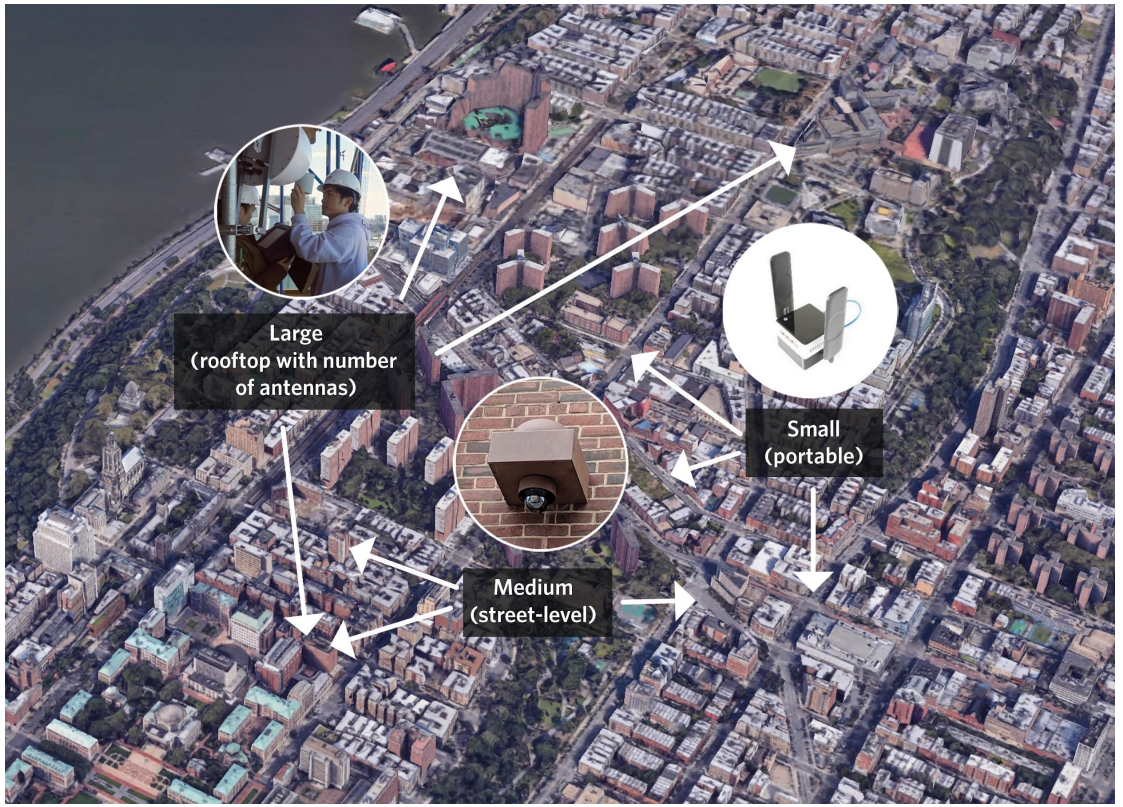
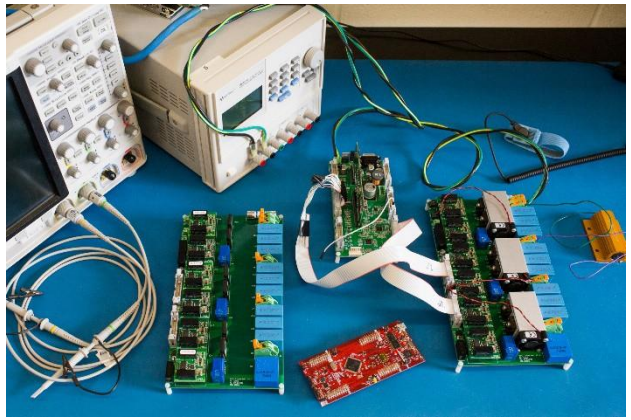
Source: IEEE Spectrum



Smart Electric Energy

- Efficient transformation and manipulation of energy in electric form.
- Applications in renewable energy, transportation, self-powered systems, …
- Interfaces & overlaps with Mechanical, Chemical, Environmental Engineering and Operations Research.
- Faculty specializations: power electronics, motor drives, energy storage, renewable energy, wide bandgap power devices, energy transfer, power grid control and cybersecurity, power management IoT
- Emerging areas: electrified transportation (electric vehicles. electric and more-electric airplanes and ships grid-scale storage, energy access



Integrated Circuits & Systems

- Core discipline within EE, leading strength
  - Key areas: connecting the physical world to digital processing; efficient computation and signal processing
  - Ever smaller devices and systems demand novel approaches, particularly for powering and communicating with numerous, small elements such as distributed sensor networks.
- Circuits is hub with extensive links to all other EE areas (devices, networking, signals, and bio-EE),
- Cross-intersections with other engineering and sciences via sensing and/or interaction with the physical world.
- Emerging areas: next generation wireless, smart power, complex cyber-physical systems
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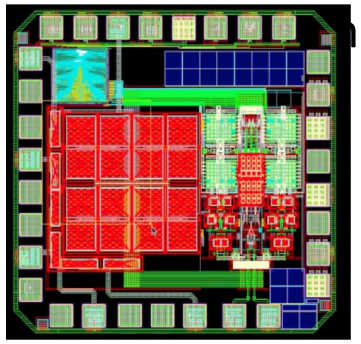
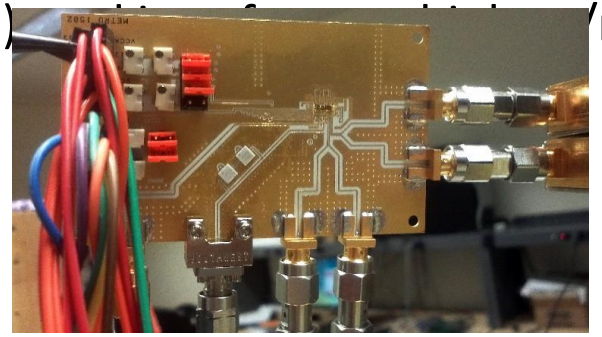
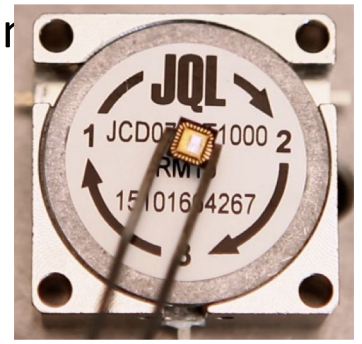
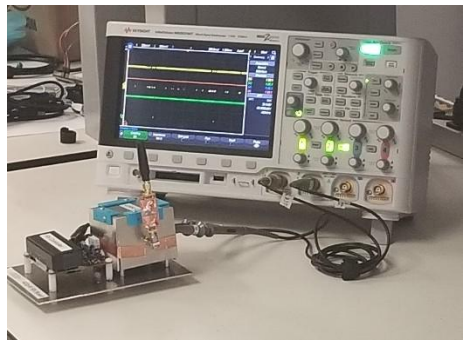
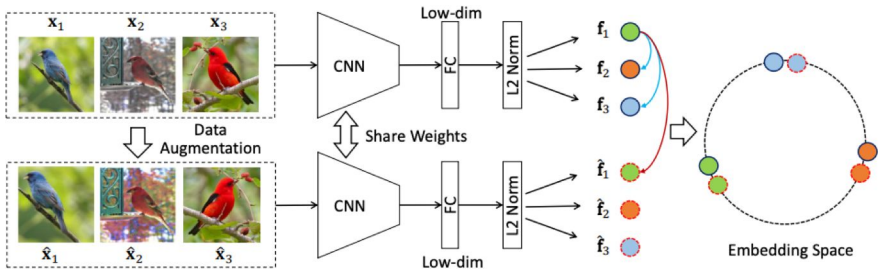
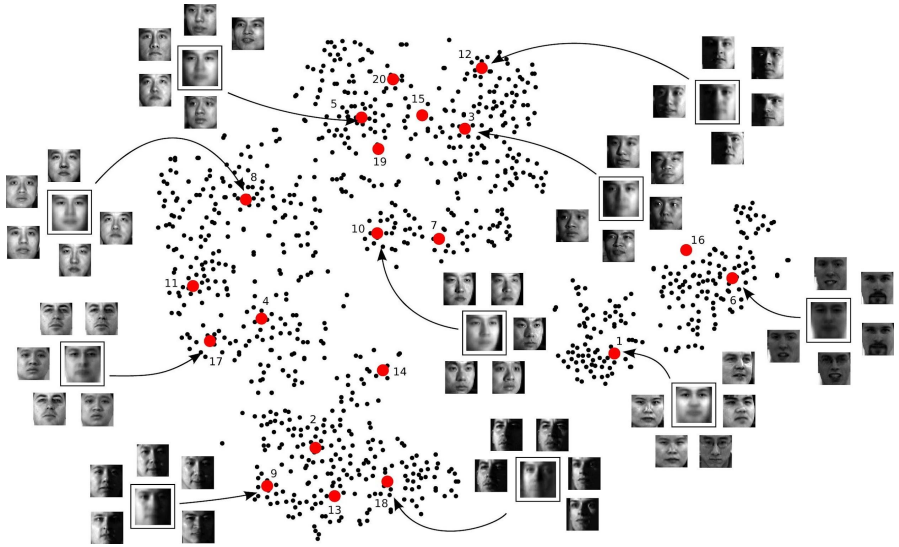




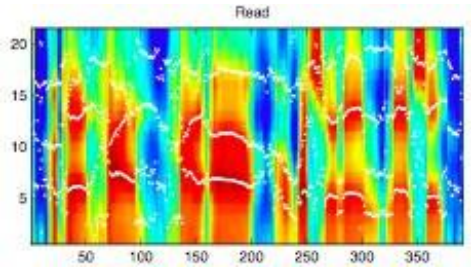


Signals, Information & Data

- Manipulating information encoded in signals.
- Applications in multimedia and communications
- Interfaces & overlaps to machine learning and statistics, strong link to data sciences
- Faculty specializations: applications including, communications, video, audio; and tools including, control, machine learning
- Emerging areas: signal processing linked to social networks, distributed sensor networks, green (low-energy) communications, sparse representations, “Big Data,” genomics, media informatics.

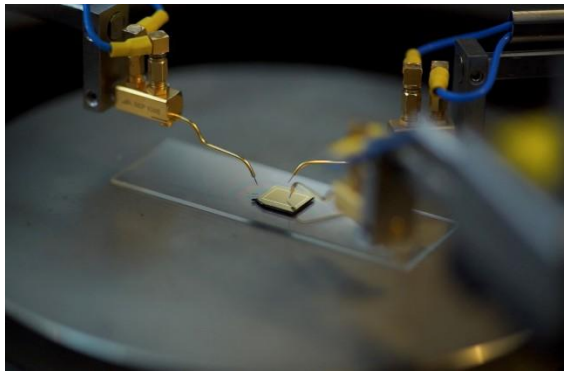


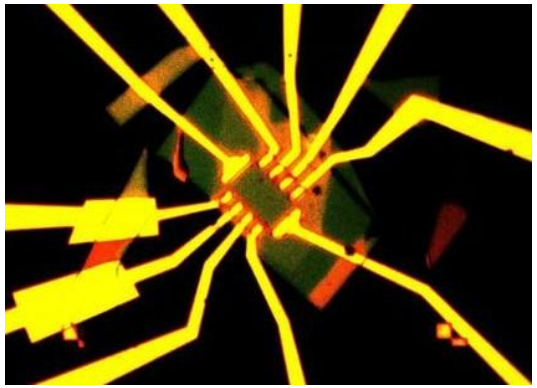


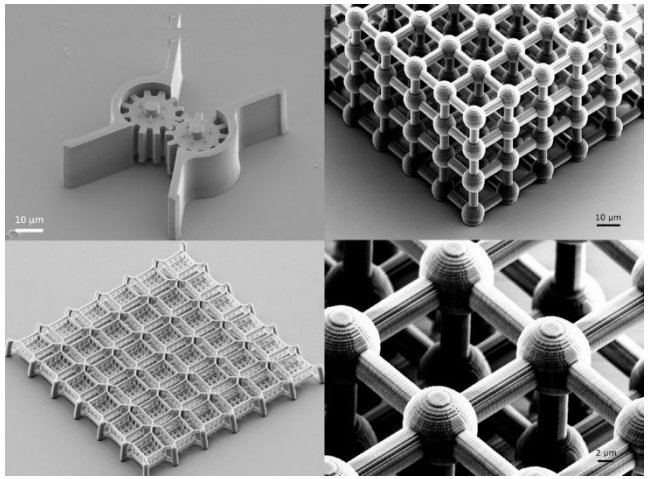


Nanoscale Structures & Integrated Devices

- Novel materials and devices created at the interface between electronics and applied physics
- Current significant activity in nanotechnology, photonics, and thin film semiconductors
  - Emphasis on 2D materials, complex oxides, and organic semiconductors.
  - Strong links to Applied Physics, Mechanical Engineering, Biomedical Engineering, Physics, and Chemistry
  - Brookhaven National Labs - strong potential for growth stemming from applications in energy, sensing, optical interconnects, and hybrid microsystems.
  - Topics are crucial to Columbia Nano initiative and many large centers (MURI, IGERT,EFRC, MIRTs, etc.)
- Key areas:
  - Devices for Energy, Communication, and Sensing
  - Novel materials
  - Optical interconnect
  - Hybrid Microsystems

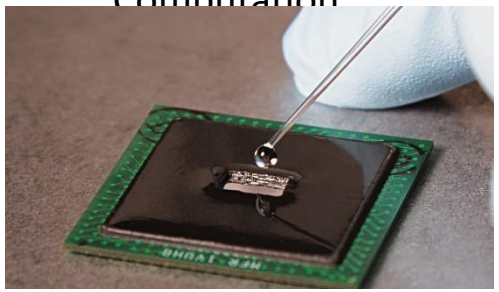


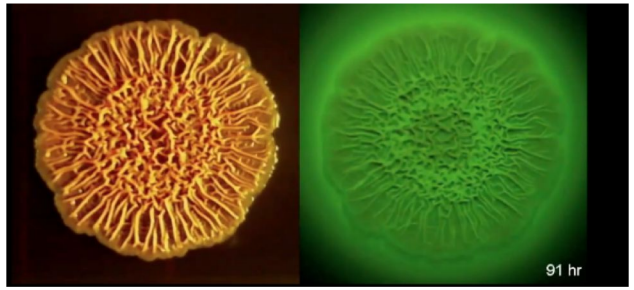


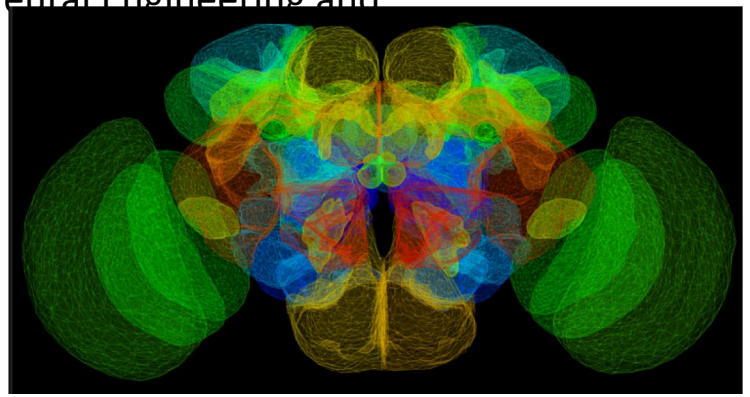


Systems Bio & Neuroengineering

- Interface between EE and biological sciences; applying systems tools & EE thinking to biological systems
- Neuro-engineering:
  - Capitalizes on Columbia's strengths in neuroscience (including MBBI and federal BRAIN program) and our computation with neural circuits.
  - Revolutionize understanding of neural information processing by reverse engineering the brain, build cognitive computational capabilities into silicon hardware.
- Systems biology:
  - Apply EE tools of analyzing complex systems to biological systems, such as genomics and protein networks.
- Highly interdisciplinary
  - Biology, Chemistry, Neuroscience, Biomedical; BRAIN Initiative; Center for Neural Engineering and Computation







Advice

- **Graduate school offers a lot of freedom but comes with a lot of responsibility**
- **Think about your whole program – make a plan of what you want to do when you graduate, learn new things (do not repeat your undergraduate classe…)**
- **Think for yourself, don't simply follow the herd**
- **Seek opportunities**
  - research, internships, seminars, workshops, clubs, …
- **Don't hesitate to ask for help or advice:**
  - Student Affairs Staff, Career Placement Staff, Faculty Advisors, Fellow Students, Alumni
  - Instructors, Teaching or Course Assistants
- **Give feedback!**
  - Chair office hours: Monday 9.30am-10am.
  - Feel free to email - johnkym@ee.columbia.edu

- **Follow us on Twitter (@EE_ColumbiaSEAS) and join the LinkedIn group (Jennifer Lee's presentation)**


DATA SCIENCE ▪ SENSING ▪ IMAGING ▪ VISUALIZATION ▪ MODELING ▪ SIMULATION ▪ MATERIALS ▪ NANOSCIENCE ▪ DEVICES ▪ ROBOTICS ▪
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CREATIVE
COLUMBIA
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FOR
HUMANITY