Cornell University
School of Electrical and Computer Engineering

Bio-Electrical Engineering

Anthony P. Reeves

http://www.via.cornell.edu/bioeleceng.pdf

http://www.via.cornell.edu -> Meng -> Bio-Electrical Engineering

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Bio-Electrical Engineering

- Nanobio Applications
  - Edwin Kan
  - Alyosha Molnar
- Bio Signal, Systems, and Applications
  - John Belina
  - Zygmunt Haas
  - Hsiao-Dong Chiang
- Image Analysis
  - Peter Doerschuk
  - Anthony Reeves

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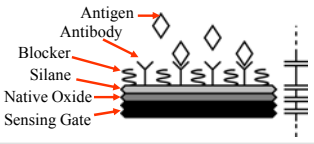
Nanoelectronics: Edwin Kan
Universal CMOS Sensor Pixels

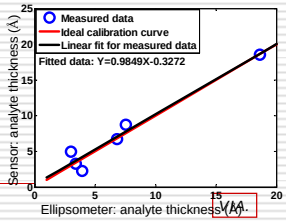
Applications

- *In vivo* sensing
- Monitoring cell events
- Specific protein sensing
- Sensor network



Features

- 100% CMOS integration
- Specificity by sensing gate coating: pressure, proteins…
- Nonlinear response: high sensitivity and large range
- Noninvasive: no need of analyte reference electrode



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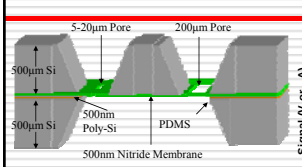
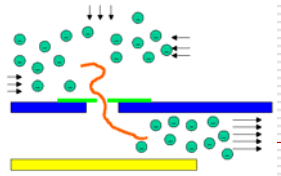
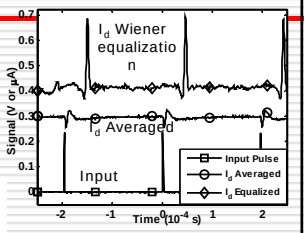
Nanoelectronics: Edwin Kan
Electronic DNA Discrimination







- Resolve 25mV/1nA electrolytic current in 1μs on top of the nitride pore in CvMOS with Wiener LMS equalization

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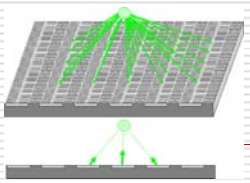
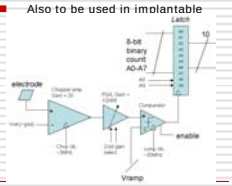
Integrated Circuits for Neuroscience
Professor Alyosha Molnar

- Angle-sensitive pixel arrays for 3-D imaging of fluorescent neurons:
  - New pixel design to extract incident angle as well as intensity.
  - Should permit triangulation of fluorescent neurons in tissue (active neurons glow)



- Massive multi-electrode arrays (MMEAs)
  - Each 40umx40um electrode detects, amplifies and digitizes extracellular potentials
  - Goal: record entire spiking output of a retina.
  - Also to be used in implantable



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Potential projects:
general contact: Alyosha Molnar (molnar@ece.cornell.edu)

- Imager testing
  - Need mixed-mode test boards and software for gen 1.1 chip
  - Goal is to demo localization of fluorescent beads
  - Contact Albert Wang (aw383@cornell.edu)
  - Good if you like messing around in lab.
- Next generation imager design
  - Need mixed mode circuit blocks designed in Cadence
  - Goal is to design a 1M-pixel 3-D camera imager.
  - Contact Albert Wang (aw383@cornell.edu)
  - Good if you are looking at a career in IC design.
- MMEA packaging + testing
  - Need bio-compatible packaging to permit interfacing of MMEA to in-vitro retina
  - Involves fluidics, electro-plating, board design.
  - May also involve signal processing + software development.
  - Contact Ben Johnson: (bjj25@cornell.edu)
  - Good if you like messing around in lab, and are interested in "wet" biology.

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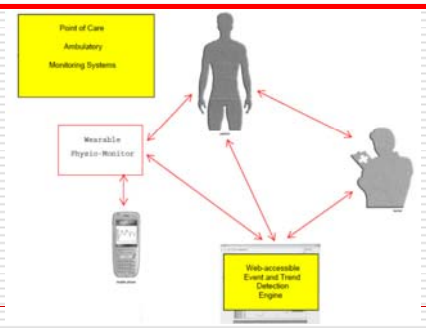
John Belina: Wearable Monitors



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The Wireless Networks Lab @ Cornell

- *Headed by Prof. Zygmunt J. Haas*
  - Contact information: *haas@ece.cornell.edu*
  - URL (including publications): *http://wnl.ece.cornell.edu*
- *Current Personnel includes:*
  - 8 graduate (Ph.D./M.S) students
  - 2 postdocs/visiting professors
  - 3 Master of Engineering Students
- *Research in our lab is focused on the effect of:*
  Mobility in wireless networks and lack of infrastructure (ad hoc technology) on the design and implementation of networking protocols
- *One of the key question that we are studying:*
  what are the limitations of the ad hoc and sensor networks in delivering real-time, secure, and manageable communication, and how to overcome those limitations using practical technical solutions
- *For 2008 M.Eng project description contact Prof. Haas directly at: haas@ece.cornell.edu*

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An Example of a Biologically-Inspired Networking Framework: Delay Tolerant Networks

- Bottle-sized acoustic tags can be injected into whales (by means of a crossbow).
- Tags collect data about whale and their environment.
- Collection Stations are distributed throughout the habitat.
- As the whales come in contact one with another, they share the information stored in their tags.
- Only one of the whales carrying a particular packet needs to come in contact with only one of the Collection Stations.

- This significantly reduces the delay in recovering the information, relative to previous systems. Our system also prevents loss of collected information, as the tags are ejected within 3 months and lost.
- Analysis of the system revealed a number of tradeoffs in its design, implementation, and operation, which could be exploit to improve its operation.

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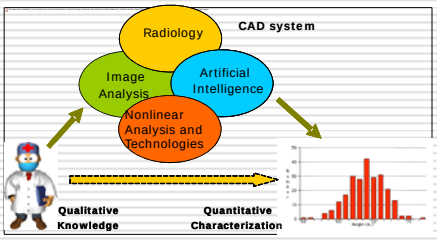
Hsiao-Dong Chiang: nonlinear feature extraction and selection and global optimization technologies

- Cross-disciplnary technologies



- Nonlinear CAD system for lung cancer diagnosis system

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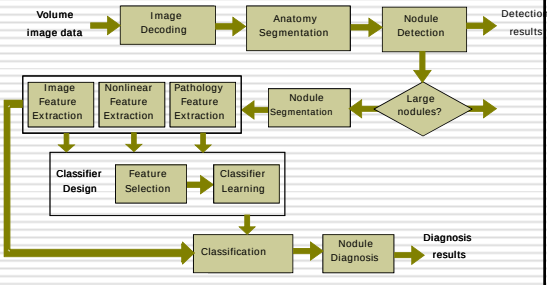
Hsiao-Dong Chiang: nonlinear CAD system for lung cancer diagnosis system



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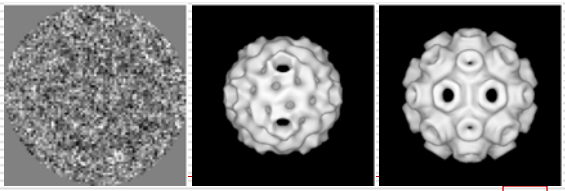
Peter Doerschuk: Nonlinear tomography

Electron microscopy of viruses and other biological objects
- Fundamentally nonlinear (projection orientations unknown).
- Low SNR (electron beam rapidly damages the specimen)
- Mixtures of multiple types of object (no ability to individually classify an image with respect to type)

Solution! Joint 3-D reconstruction of multiple types of object simultaneously
- Bayesian statistical methods
- high performance parallel computing.



Original image 3D-recon Object type 1 3D-recon Object type 1

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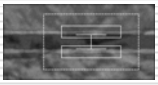
Vision and Image Analysis Group (VIA)

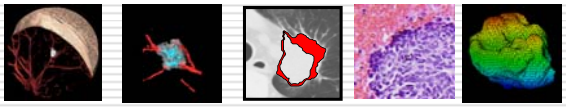
Anthony P. Reeves
School of Electrical and Computer Engineering

Mission:

A. Accurate measurements from multi-dimensional images

B. Computer methods for image analysis





Web Site: www.via.cornell.edu
Web-based image tools: www.via.cornell.edu/databases/

Detection, Characterization, Measurement

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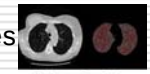
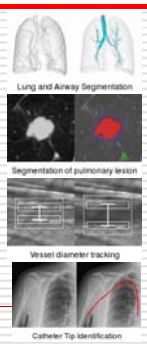
VIA MEng student opportunities

More information: www.via.cornell.edu -> MEng



- Research Collaboration
  - Weill Cornell Medical College in NYC
  - Life Sciences in Ithaca
- Resources
  - Web based image management, international participation: 40 clinical sites
- Projects
  - Compute Aided Diagnosis: aiding the physician in diagnosing disease



Detection: *Does it exist? Where is it located?*
Characterization: *What is it?*
Measurement: *How big is it? How many are there?*

A. P. Reeves
MEng. Projects

- Experience in computer vision necessary … take ECE 5470
- Group project of segmentation of organs in CT chest scans… virtual anatomy
- Other projects may be considered.

http://www.via.cornell.edu/students.html

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