Fall 2009 Mentors

**Prior Mentors in the PURE Program:**

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<th>Active?</th>
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<th>Mentor</th>
<th>Research / Project Summary</th>
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<td><img src="image1.jpg" alt="David Jun - Signal Processing" /></td>
<td>David Jun - Signal Processing</td>
<td>Have you ever wondered about the technology that makes artists such as T-Pain, Lil Wayne, and Kanye West sound so good? It is commonly known as Autotune, and this project is all about understanding the theory behind how it works, designing/simulating a similar system, and if time permits, implementing it on your platform of choice. More info about Autotune can be found at <a href="http://en.wikipedia.org/wiki/Auto-Tune">http://en.wikipedia.org/wiki/Auto-Tune</a>. You can download a working free version at <a href="http://web.mit.edu/tbaran/www/autotalent.html">http://web.mit.edu/tbaran/www/autotalent.html</a>.</td>
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<td><img src="image2.jpg" alt="Erik Johnson - Signal Processing" /></td>
<td>Erik Johnson - Signal Processing</td>
<td>I would like to work with mentees to find a research question of mutual interest and design a system to explore this question. Some areas of interest to me include imaging algorithms (reconstructing pictures or 3-D images of an environment from simple signals), radio jamming (such as radar countermeasures or communication jammers), video processing (using cheap webcams for surveillance, tracking, recognition), algorithm implementation (parallel and distributed implementations of signal processing algorithms), and Human computer interaction. We’ll build a practical system (it might be a real, physical system or a computer simulation) and use it to explore algorithms and techniques to answer our question. The system could be demonstrated at Engineering Open House in the spring semester, and the research results can be presented at the PURE symposium or the Undergraduate Research Symposium. Our project will most likely be software-based and we will try to implement our hardware with cheap, consumer options (such as webcams).</td>
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**Inactive Mentors**

The following mentors are from past semesters, or will not be taking new mentees this semester. If you are looking for Mentors who will be recruiting for this current semester, see the Active Mentor Listing.
Hamed Okhravi - Computer Security

- Multi-level security systems
- High assurance workstations
- Virtualization (Xen, KVM, ...)
- Formal methods for security verification
- Trusted O/S
- Trusted IO and graphics
- Information leakage detection and information flow analysis
- Covert channels (analysis and prevention)
- Secure hardware support (TPM chips) for all of the above

Mentees can choose the topic that interests them. Promising results will be published.

Jacob Adams - Electromagnetics, Antennas, Microwave & RF (Sem. 2)

My current research is focused on analysis and design of antennas. I am using a method called Characteristic Modes to design and analyze the behavior of antennas. Right now, I am studying electrically small antennas and I plan to eventually extend this to multiport antennas and possibly others. In addition to performing analytical and numerical analysis on these antennas, we also build and test them.

Michael Daly - Electromagnetics, Antennas, Microwave & RF

I'm interested in the design of antenna elements and how they can be optimized for specific system applications. At the antenna level, antennas that are reconfigurable (in radiation pattern, frequency band, or polarization) continue to be a topic of interest, as do multi-port antennas. At the system level, MIMO and other wireless applications are a driving force. My past research has included designing a frequency-reconfigurable element and designing a system-level method for synthesizing digital signals with the antennas themselves. We can discuss which part of antennas interests you and zero in on a do-able project.

There are multiple projects available:
1) An investigations on algorithms for solving non-cooperative games with coupled constraints
2) Design of control policies for optimal intrusion detection systems
3) Game-theoretical modelling of intrusion detection systems
Quanyan Zhu - Game Theory & Control Systems

4) Robust and secure control design of distributed networked systems in malicious environment
5) Application of sum-of-squares in control system analysis and design
I also encourage students to find their own topics within my scope of interest.

Sanketh Shetty (Computer Vision and Pattern Recognition)

My research is centered around high dimensional data clustering and analysis. I primarily work in developing nonparametric algorithms for detecting interesting clusters and patterns in high dimensional data. I also work on developing supervised and semi-supervised ML algorithms that bootstrap on structures detected by unsupervised learning methods.

I have a few ideas for projects this fall. From my previous experience in PURE I have found it more helpful to define a broader project and let students hone in on their interests as the semester progresses. I also pick one area that I consider myself an expert in and the other to which I am almost as new as the mentees.

The plausible areas of projects include:

1. Spectral Algorithms for Data Clustering
2. Recognizing Handwritten text / Detecting Faces/People in Images and Video

Santosh Tripathi - Optical Imaging and Characterization

My research interest is on the use of light in nanostructure characterization. Currently I am fleshing out the details of a high speed ellipsometer that we recently proposed and over the fall I will be building and testing it. However, mentees do not have to be a part of this effort for there are several small fun problems to work on. Two of them are listed below and you can discuss more by sending me an email. If you have any problem that you want to work on, that is also all right.

1. Optical Tweezer: Optical tweezers use light to manipulate small particles. In this project, mentees will analyze the forces acting on a nanoparticle trapped by an optical tweezer as the particle is moved from one medium to the other.
2. Vector beam characterization: Vector beams are optical beams which have different polarization at different points of the beam. In this project, mentees will write computer code to analyze experimental data collected for analyzing vector beams.

I am working on a reconfigurable null antenna which has use in
Siwen Yong - Electromagnetics, Antennas, Microwave & RF communications. This involves the design of an antenna with a null in its radiation pattern before investigating various methods to tilt the pattern.

Taylor Johnson - Controls (Fall 2009)

Our research is focused in two areas: that of control systems, such as regulating temperature in a building with a thermostat and air conditioner, and that of distributed systems, such as the groups of computers that make large websites work, in particular dynamic operations like search and data storage. In particular, we are interested in next generation distributed control systems, such as groups of UAVs performing tasks together, or working towards the practical realization of the automated highway system (AHS). A multitude of other example systems exist.

Xiaolan (Joy) Zhang - Computer Networking Systems

My research work is to advance optical networking technology to support dynamic high speed optical traffic in a rapid and robust manner. The work includes developing advanced routing and dimensioning techniques for a single wavelength routed network and multiple individually managed domains. The work also includes developing network management systems to provide fast load-balancing for long-haul carrier networks and the infrastructure of stream processing systems (IBM InfoSphere Streams). Our study can improve networking resource allocation for a variety of emerging high bandwidth applications.