Undergraduate Research Activities and Opportunities
In the Department of Electrical and Computer Engineering, University of Miami
Fall 2014
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3. Evolvable Hardware / Digital Cryptography |
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## Detailed Project Descriptions

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<td>Dr. Mohamed Abdel-Mottaleb</td>
<td><strong>Biometrics research</strong></td>
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<td>Recognizing people from facial and ear images. Student who will participate in this project will work closely with Ph.D. students who are performing their research in these topics. Students will learn basics of image processing and will get involved in some interesting topics including face and ear modeling and matching.</td>
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<tr>
<td>Dr. Xiaodong Cai</td>
<td><strong>1. Dynamic Modeling and Simulation of Gene Networks</strong></td>
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<td>Apply dynamic systems and control theory as well as signal processing methods to model and simulate the dynamics of gene networks. Possible collaboration with professors in the medical school. The project is particularly suitable for engineering students who are interested in biological or biomedical research.</td>
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<td><strong>2. Identification of Gene Regulatory Elements</strong></td>
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<td>Use computational methods to analyze genome sequences and gene expression data and to identify possible gene regulatory elements in the genome. Possible collaboration with professors in the biology department. Good programming skills are required.</td>
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<td>Dr. Sung Jin Kim</td>
<td><strong>1. Nano for Sensors</strong></td>
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<td>This research will focus on nanophotonics and their Biosensor applications. Surface Plasmon Resonance (SPR), Metamaterials/structures and photonic bandgap structures, which are currently a cutting-edge research area, will be studied. This project will include FDTD (Finite Difference Time Domain) simulation for light-matter interaction and BPM (Beam Propagation Method) for waveguide structures. Also, there will be device fabrication for a prototype sensor system using optics and photonics based theory. This project will lead to students having deeper understanding of optics and nanophotonics for sensors.</td>
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<td><strong>2. Nano for optoelectronics</strong></td>
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<td>This research will focus on optoelectronic devices (solar cell, light emitting devices) using nanomaterials and nanostructures. There has been lots of research regarding unique optical properties of nanomaterials, which can be used for display or LED devices. This research will include techniques for solution processed device fabrication using nanomaterials and nanostructures. For example, next (3rd) generation solar cell will use nanotechnologies for flexible, low cost production. Various organic/inorganic materials (e.g., quantum dots, nanoparticles, carbon nanotube, graphene and polymers) will be studied and students will have opportunities to learn how nanomaterials are synthesized and used for solution based device fabrication as well as electrical/optical device characterization techniques.</td>
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| Dr. Miroslav Kubat | 1. **Climatological Research**  
The use of advanced data analysis in climatological research. Application of regression trees to the problem of correcting remote-sensing data.  
2. **Machine Learning**  
The use of machine learning techniques in domains with highly unreliable data. |
|-------------------|---------------------------------------------------------------|
| Dr. Shahriar Negahdaripour | 1. **Recognizing fish in video images**  
Novel machine learning techniques and object labels on massive amount of internet data have enabled fast and accurate searches, in addition to recognition objects from their images. In this project, the objective is to apply similar ML methods to large volume of deep-sea optical and sonar data from the Virgin Islands to classify certain fish, namely various types of grouper (yellow-fin, grouper, Nassau, tiger, yellow-mouth) and snapper (cubera, dog).  
2. **Recognizing/locating 3-D objects on the seafloor using forward-scan sonar data**  
In recent years, high-resolution sonar video cameras have been commercialized that produce images with high target details. In this project, application of computer vision techniques are explored to classify and (or) identify 3-D objects using 2-D sonar images. In other related work, we are also interested in fusing information from both optical and sonar images.  
3. **GUI for Human-Assisted Control of a Commercial Submersible Robotics Platform**  
There are a number of projects involving the development of graphical User Interface with Visual C++, or comparable environments (e.g., Python) for sensor output display, control and interaction of the submersible robotics platform owned by the Underwater Vision and Imaging Lab. |
| Dr. Kamal Premaratne Dr. Manohar Murthi | **Multi-modal data fusion**  
In many applications, one is confronted with massive amounts of various forms of data (e.g., text data, sensor data). For example, doctors are confronted with transcriptions of patient statements, blood pressure readings, and so forth. This project involves investigations into fundamental methods for making sense of and fusing various forms of data (e.g., text and sensor data). |
| Dr. Manohar Murthi | **Quantization of signals for robustness to packet loss**  
This project involves fundamental work on signal/data compression for transmission of networks that feature packet loss. In particular, we are investigating distributed source coding principles (commonly known as Wyner-Ziv principles) to code speech with robustness to packet loss while featuring efficiencies closer to predictive coding models. This has applications to audio/video coding and transmission. |
|-------------------|-----------------------------------------------|
| Dr. Michael Scordilis | **1. Array Processing**  
Investigation of one-, two- and three-dimensional sensor arrays with emphasis on small, adaptive geometries for effective detection, enhanced signal-to-noise ratio and ability to track multiple sources.  
**2. Affective Signal Processing**  
Affective computing will become very relevant in future human-machine interaction. Methods for good spoken emotion recognition that have been recently developed need to be augmented with other types of biosignals so that classification can be improved. |
| Dr. Mei-Ling Shyu | **1. Multimedia Content Analysis and Data Mining**  
To extract information about the content conveyed by the data, using more than one media (audio, video, text, etc.).  
- Image, video, and audio processing  
- Feature evaluation & selection  
- Video segmentation and data preprocessing  
- Multimedia databases  
- Event detection using multi-modal content analysis and data mining  
  - Sports highlights - touchdown, corner kick, dunks, and more  
  - Surveillance – people entering and exiting room under security surveillance  
- Concept identification and detection  
  - Classify broadcast video segments to sports, whether, and other  
- Evaluation and/or development of feature combination methods using different data mining techniques  
  - Decision tree  
  - Association Rule Mining  
**2. Network Security/Network Intrusion Detection**  
To develop effective and efficient frameworks for network intrusion detection.  
- Network traffic generator/simulator  
- Network programming/multi-threaded programming  
- (Near) Real-time intrusion detection systems  
- Distributed multi-agent based intrusion detection systems  
- Data mining-assisted network intrusion detection systems |
| Dr. Onur Tigli | We are interested in developing nanotechnologies for the early diagnosis and therapy of cancer. Students carry out research at our state-of-the-art lab facilities at UM Miller School of Medicine as a part of Biomedical Nanoscience Program. |
1. Nanotechnology and Biosensors for Cancer Diagnosis and Therapy

My lab’s interest is in the field of bioMEMS/ NEMS to develop smart point-of-care diagnostic tools for clinical applications. Our current research deals with the development of zinc oxide (ZnO) nanowire based biosensors, as well as development of integrated micro/nano systems for rapid and comprehensive blood, serum and other bodily fluid analysis. This work involves the use of micro/nano fabrication methods, microfluidics, micro/nano sensor and actuator development, and their biomedical applications. Additionally, he also conducts research for monolithic lab-on-a-chip, integrating nanotechnology with conventional CMOS technology.

2. Energy Harvesting Microdevices

This project is focused on the design of micron scale devices for harvesting energy. Students can participate in the modeling and simulation of such devices using cutting-edge MEMS software tools (COMSOL, ANSYS, Coventorware etc.) Students will also be involved in basic microfabrication tasks to post-process CMOS fabricated microchips that employ energy harvesting components. They can also assist in experiment setup that will include basic electrical circuits and mechanical apparatus for testing and characterization.

3. Evolvable Hardware / Digital Cryptography

Hardware description languages (HDL) and logic synthesis made high levels of integration and large gate count ASICs and FGPAs possible. Our primary interest in this field is to utilize FPGAs in developing evolvable hardware component libraries for applications in cryptography through the introduction of evolvability at behavioral, RTL, logic synthesis, or in physical layout by localized evolution engines. Strong background in Verilog HDL, digital design on FPGAs and C programming is required. Students can assist graduate researchers in algorithm, coding and performance testing.

Dr. Michael Wang

3D Image Acquisition and Display

Currently, human finger prints are acquired mainly in 2D images. It would be interesting to acquire 3D finger prints without contact. An imaging device can help the acquisition of 3D image data. In this project, the goal is to acquire 3D finger prints and make a suitable display. Require software processing skills to make this possible.