Embedded sensors are becoming pervasive and collect massive amount of data about the physical world such as temperature, humidity, light, pressure, audio, video, etc. This big data, once analyzed using latest advancements in inference techniques, e.g. machine learning techniques in particular, can bring about new knowledge, applications, and business opportunities. The most notable successful example of this is Fitbit, with more to follow in the next few years. In this exciting space, my research focuses on system design and optimization, to ensure the efficient execution of these sensing and inference systems.

LONG LE

Possible Projects

We have an embedded kit that includes a BeagleBone Black which acts as a gateway to the cloud for various sensors, ranging from temperature, humidity, light, pressure, and vibration, to AC power and audio. You can find more details at https://github.com/terraswarm/urban-heartbeat-kit. Your project is to set the kit up so that the sensors start sending data to the cloud.

Desired Coursework/Experience:

The main requirement is interest in embedded systems, some programming experience is desirable but not required.

Additional Questions for Applicant

NA
I am a PhD candidate in the ECE Department at the University of Illinois at Urbana-Champaign. I am being co-advised by Angelia Nedich and Carolyn Beck. My research includes the development and study of mathematical models of virus spread across systems that have time-varying graph structure. This work is applicable to biological networks, population networks, computer networks, etc.

Possible Projects

- Learn how to write a simple virus simulation in Matlab and plot the results. If the simulation is interesting enough it will be uploaded to the youtube channel UIUC Virus Models.

- Use existing code to run a set of experiments that will be used to analyze/compare various virus models. Prepare the data and present it in a way that is useful and easy to interpret.

Desired Coursework/Experience:

- Any Matlab (or any coding) experience would be nice but not necessary. Some mathematical background (linear algebra, ODEs, real analysis) would also be nice but again not necessary.

Additional Questions for Applicant

- Why are you interested in doing research?

- What is your goal of participating in this program/what do you hope to get out of it?
My research focuses on nanoscale energy science. Green energy from wasted heat sounds like a free lunch, but thermoelectric materials do provide a promising vehicle. Dictated by the second thermodynamic law, a great amount of energy input is being (has to be) wasted in the form of heat. As global economic activities explode, thermal waste also spikes due to the sharp rise of energy expenses. Among all the others, thermoelectric materials convert heat directly and cleanly into electricity, without any moving parts and very high specific power (i.e., remarkable advantage in maintenance and scaling). However, due to tightly interrelated but competing requirements in material properties, the pursuit of high thermoelectric performance has proven strenuous for nearly 200 years. Nonetheless, the figure of merit experienced a sudden jump thanks to improvements in nanoscale fabrication and synthesis. We are currently studying phonon transport on two-dimensional superlattices using molecular dynamics, lattice dynamics, as well as density functional perturbation theory. Our primary concerns are two-fold: i) the anomalous transport physics, such as the dependence of thermal properties on structural dimensions; and ii) possible high-throughput designs for practical applications.

Possible Projects

Two possible projects are possible based on mentees’ interests, one numerical one physical. The numerical study will focus on developing numerical methods to simulate thermal energy and electron transport in thermoelectric materials. I myself have developed a great part of the codes, and the mentee is expected to join me to finish the code. The other project will be discovering new thermoelectric materials/nanostructures using available atomic simulation packages. For the latter, I will play with the software with the mentees and adventure the discovery of new thermoelectrics.

Desired Coursework/Experience:

For the numerical project, the mentee should know preliminary programming skills and at least one programming language. The numerical algorithm will be discussed during regular meetings.

For the physical project, the mentee is expected to has some experience with commercial or open-source software. We will discuss the software and physics embedded together.

For both projects, we will contribute genuinely to the renewable energy community and work seriously to publications. Therefore, the mentee should have sufficient patience and enough time.

Additional Questions for Applicant

NA
I am a fourth-year Ph.D. student in ECE co-advised by Prof. Andreas Cangellaris and Prof. Jose Schutt-Aine. My research is in the area of stochastic modeling for electromagnetics and signal integrity applications. I invent and develop simulation methodologies and tools that allow computer system designers to simulate the signaling performance of their designs even when some input parameters or the exact system is uncertain. Traditionally, these analysis are performed using time-consuming Monte-Carlo sampling methods. My work in Stochastic Collocation and Stochastic Galerkin methods have allowed the same analysis to be performed much faster.

I received my B.S. from ECE ILLINOIS in 2005. From 2005-2012, I was a Signal Integrity Engineering with IBM Systems & Technology Group in Poughkeepsie, NY, working on mainframe, supercomputer, and workstation systems. In summer of 2013 and 2015, I was an intern at Apple Inc. in Cupertino, CA, working on Electronic Design Automation. This is my fifth time mentoring PURE. In each of the last four semesters, one of my mentees has won an award at the PURE Symposium each time. Two of my mentees have published their PURE research in IEEE conference papers.

I am currently an instructor for ECE 329. I have been on the UIUC List of Excellent Teachers for Fall 2014 and Spring 2015. I am also the recipient of the E. A. Reid Fellowship and H.L. Oleson Award for outstanding undergraduate teaching.

Possible Projects

Linear system macromodeling with passivity constraints – When constructing mathematical models for electrical behavior of complicated physical systems, it is often infeasible to characterize the system based on the underlying first-principles. For instance, we wish to model the interconnects on a computer motherboard but it is difficult or expensive to do so using only Maxwell’s equations, due to the complexity of the motherboard. Hence, macromodels are often employed to capture the behavior of the system without containing all the details of the physical design. In other words, the effects of loss, crosstalk, dispersion, etc. can be captured using a transfer function. This enables efficient and accurate simulation of the system, and is the current standard technique being employed in industry. If the transfer function is fitted to a rational function, then it can be characterized by the poles and residues, and enables a recursive convolution algorithm to be used for the time-domain simulation, which is more efficient than regular convolution. However, rational approximations of transfer functions sometimes become unphysical, possibly violating physical constraints such as passivity.

For this project, we wish to find a technique to fit measured or simulated transfer functions into rational functions, while preserving the underlying causality, stability, and passivity of the system. A possible way to accomplish this is to use existing toolkits to find the poles and residues of a system, then shifting the poles within a range weighted by the probability density function, and arrange them in such a way that they are physically consistent.

Desired Coursework/Experience:

ECE 210. Credit or currently taking ECE 313, 329. This project will require extensive use of numerical software such as MATLAB. Ideal candidate should have mathematical maturity. Meetings on weekends may be required due to faculty advisor’s busy schedule.

Additional Questions for Applicant

a: What is your area of interest in ECE and what do you plan to do after graduation?

b: Are you willing/able to have research meetings on the weekends?

c. What courses are you registered for in Spring 2016?
I am a 1st year PhD student in Electrical and Computer Engineering working with Professor Timothy Bretl. My area research is in robotics, specifically involving visual-inertial navigation.

The current objective of the Bretl Research group is to automate the process of building and infrastructure construction monitoring. Since this monitoring is performed using cameras onboard a ground or aerial robot, effective visual-inertial navigation is an important enabler of this application area.

Possible Projects
Undergraduate student projects would be in the area of inertial navigation. Mentees may (1) finish an inertial navigation platform, (2) conduct experiments of the inertial navigation system, and/or (3) write basic code processing inertial sensing information.

Desired Coursework/Experience:
You should expect to spend at least 5 hours per week on this project. We will have weekly meetings.

Additional Questions for Applicant
What type of project would you like to work on?
Wen Huang

Research Area: Nanotechnology, Radio frequency integrated circuit and system

Research Advisor: Xiuling Li

Contact: whuang82@illinois.edu

My research focus on rolled-up-nanomembrane (RUN) tube for on-chip RFIC passive electronics, sensors and biomedical devices. I work in Prof. Xiuling Li’s group in the ECE department, and conduct systematically research of RUN-tube platform including tube structure design, mechanical/electrical simulation, nanofabrication and device performance characterization. You can find a full information about my latest research work on my website.

https://publish.illinois.edu/ece-wenhuang/

Possible Projects

Learn nanotechnology about fabricating RFICs. Help to do cleanroom work to fabricate on-chip RFIC passive components. Students will have opportunities to get trained on cleanroom skills and work in the cleanroom with senior members in Prof. Xiuling Li’s group.

Desired Coursework/Experience:

Mentee’s Commitment:

5 or more hours per week, but flexible as long as the assigned task is done by the end of semester.

Requirements/Qualifications for Mentees:

Highly self-motivated. Know EM theory. Know some nanotechnology.

Additional Questions for Applicant

A. How would you describe yourself? (Anything is fine, like you can talk about yourself in daily life or academic activities)

B. What do you plan to do after graduation?

C. Please describe as much as you can – what is the most important RFIC on-chip passive device? And why?

Please send you answer and your CV to whuang82@illinois.edu. The subject line is: “PURE_your name”

ABHISHEK DHOBLE

Possible Projects

1. Arduino® based pH controller for anaerobic digester
Since the beginning of time, a human has been fascinated by the moon. The National Aeronautical and Space Administration (NASA) solidified its goal of a ‘Colonization of the Moon’ as a reality in the near future. The Lunar outpost will be an inhabited facility on the surface of the Moon which NASA currently proposes to construct over the five years between 2019 and 2024. Waste treatment and removal for missions to moon will be more challenging due to the longer mission duration regardless of complications from the environment. Waste management for such missions may employ more efficient versions of technologies than developed for Shuttle or completely different approaches may be more cost effective. Depending on the mission protocols, indefinite stable storage for the end products of any waste processing scheme will be necessary. Historically wastes generated during human spaceflight are materials with no further utility requiring only storage until missions end. However, Exploration Waste Subsystems may reclaim resources from input wastes allowing greater closure within the overall life support system. The waste subsystem collects waste materials from life support subsystems and interfaces. Current NASA spacecraft waste handling approaches essentially rely on dumping and/or storage. For future long duration Lunar mission, it is practically impossible to get all the stored wastes back to the earth and the waste generated over a year cannot be dumped in Lunar surface. Several studies have highlighted the importance of a technology called ‘Anaerobic Digestion’ which not only reduces the wastes on the Lunar surface, but may provide significant fuel out of it during a year of exploration. anaerobic digestion or biogasification is a biological process in which microorganisms break down organic matter into methane and carbon dioxide under anaerobic (or no oxygen) conditions. The technology is ideally suited for space mission, as it does not require oxygen. The current research efforts focuses on focuses on developing a novel flow cytometry based method with concurrent utilization of a community fingerprinting technique based on automated ribosomal intergenic spacer analysis (ARISA) to characterize the dynamics of the microbial communities in anaerobic digesters mentioned above. We propose to use this novel ‘dual’ technique for potentially monitoring and analyzing dynamics of the microbial communities to yield informative models for understanding and engineering the function of other complex microbial communities, such as in the human gut, soils and oceans.

2. Modeling microbial diversity in anaerobic digester through STELLA ®

3. Computational analysis of high-throughput flow cytometry data using Machine Learning
(Artificial Intelligence)

4. Flow assisted cell sorting and subsequent Illumina® sequencing of methanogens in anaerobic digester

Desired Coursework/Experience:
Desired but not required: A prior experience in Arduino based microcontrollers, Mathematical Modeling, R and synthetic biology lab skills.

Additional Questions for Applicant
1. Are you a dynamic individual who is genuinely passionate about environmental sustainability? Why?

2. Do you consider yourself an entrepreneurial personality who recognizes opportunities in waste-to-energy systems that would be simultaneously profitable and environmentally sustainable? If yes, please provide a brief overview of your vision.

3. Do you like getting challenged? Please explain briefly why do you feel you are ready for real responsibilities and want to make a real difference.