IoT Sensors and Systems

- **Course**: CS6501/ECE6501 (008) - Fall 2017
- **Instructor**: Brad Campbell
- **Time**: M/W 10:30am-11:45am
- **Location**: 340 Rice
- **Office Hours**: Tu 2pm-3:30pm, 512 Rice

The Internet of Things promises to revolutionize how we interact with computers by making embedded computation ubiquitous. New devices will be added to cities, to homes, to factories, to ourselves (inside and out), to cars, and to many other facets of life. The hope is that this influx of technology will help us solve many pressing societal issues in areas such as energy, personal health, the environment, and safety. The challenges lie in designing and scaling the hardware platforms, networking protocols, and programming paradigms to enable this new class of computing to be used productively.

This course will start by covering several key application areas and various systems that address issues within those applications. With the application drivers in place, we will explore the hardware platforms that support the sensing, energy, and deployment requirements of the various application domains. With methods to build the IoT devices and ensure they are low power, we move to techniques for providing connectivity to individual and networks of devices. We then will investigate systems for programming and providing security primitives for the networks of devices, as well as how the IoT can expose new privacy concerns.

As a graduate seminar, this course will focus on reading, analyzing, and discussing research papers. The course will focus on very recent research (last 2-5 years), but will also include older, more foundational papers for certain topics.

Deliverables

This seminar requires three main deliverables from students.

1. Paper Reviews

Before each class you must read and write a short review of each assigned paper. The review should answer the following questions:

- What is the problem this paper addresses, and why is it important?
- What is the hypothesis of this paper?
- What are two key assumptions that this paper makes?
- What are the two main strengths of this paper?
- What are the two main weaknesses of this paper?
- Which figure or experiment was most compelling in support of the hypothesis, and why?

Additionally, the review should include ratings for how you perceive the paper in the following categories:

- Presentation (1-5):
- Interest (1-5):
- Impact (1-5):
- Overall (1-5):
- Confidence (1-5):

The reviews must be entered in the review site (http://cs6501-008-f17-hotcrp.cs.virginia.edu/) before the start of each class and should be used as reference notes for the in-class discussion.

Note: it will always be easier to find weaknesses than it is to find strengths when reviewing a paper. After all, the authors had a limited number of pages! Try to find the merits that lead to the paper getting accepted while you read each paper.

2. In-class Discussion Lead

You must select one class where you will be the discussion lead for the assigned papers. You should come prepared to give an overview of the paper, and guide a discussion about the strengths, weaknesses, and potential for impact of the paper.

3. Semester Project

This class will feature a semester long project focused on idea creation, idea motivation, and the scientific method. You will choose a topic, develop a hypothesis within that topic, develop a research plan to explore and evaluate that hypothesis, provide some motivating preliminary data, and communicate these results in the form of a written paper.

Note: this does not require actually building the system. In fact, it requires that you *do not* build the system, but rather work on the science aspects before undertaking the engineering.

The project will have four milestones:

1. Monday, September 25: Two page paper covering your hypothesis, motivation, and expected results.
2. Wednesday, October 25: Four page paper with planned experiments.
3. Monday, November 27: Five to six page paper with preliminary results.
4. Wednesday, November 29 and Monday, December 4: Project presentations.

For the two in-class project workshops, you will be expected to evaluate and provide feedback for your peers' papers.

Grading

Your grade for the course will be based on: individual or group project (34%), paper reviews and peer-review of final projects (33%), and in-class participation and discussion lead (33%).

Schedule

Class	Topic	Lead	Details
Wed Aug 23	Introduction	Campbell	
Mon Aug 28	Ubiquitous computing and the IoT	Campbell	No reviews: (1) Ubiquitous Computing, (2) IoT Research Challenges
	Applications		
Wed Aug 30	Outdoor and Wildlife Monitoring	Campbell	(1) Great Duck Island, (2) Bat Tracking
Mon Sep 4	Urban Environments	Campbell	(1) Array of Things, (2) Air Quality
Wed Sep 6	Buildings and Energy	Campbell	(1) Sentinel, (2) CapNet
Mon Sep 11	Democratic Monitoring	Campbell	(1) SeaGlass
Wed Sep 13	Personal and Population Health	Campbell	(1) LIBS, (2) Opo
Mon Sep 18	Infrastructure and Industrial	Campbell	(1) Pipeline, (2) Alps
Wed Sep 20	Safety and Security	Anderson	(1) Gunshot Detection, (2) LOOKUP
Mon Sep 25	Project Workshop 1		Bring first version to class.
	Sensors, Hardware, Energy		
Wed Sep 27	Hardware Platforms and Smart Dust	Campbell	(1) TelosB, (2) M3, No review: (3) Firestorm
Mon Oct 2			No class (Reading day)
Wed Oct 4	Energy Harvesting 1	Campbell	(1) HydroWatch, (2) Monjolo
Mon Oct 9	Energy Harvesting 2	Campbell	(1) Tragedy of the Coulombs, No review: (2) DoubleDip
Wed Oct 11	Hardware Generation and Sensing 1	Campbell	(1) EDG, (2) Soli, No review: (3) Synthetic Sensors
	Networking and Interfacing		
Mon Oct 16	Low Power Wireless	Crump	(1) LPL, (2) LWB
Wed Oct 18	Networking		(1) IP is Dead, Long Live IP, (2) Interscatter
Mon Oct 23	Gateways and Whitespaces	Campbell	(1) Gateway Problem, (2) SNOW
Wed Oct 25	Project Workshop 2		Bring second version of the project paper to class.
Mon Oct 30			No class (SOSP).
	Programming and Security		
Wed Nov 1	Operating Systems	TockOS	(1) SOS, (2) DINO
Mon Nov 6			No class (SenSys). Work on project paper.
Wed Nov 8			No class (SenSys). Work on project paper.
Mon Nov 13	Blockchain: Hype or Useful?	Campbell	No Review: (1) Blockchain Overview (https://spectrum.ieee.org/static/special-report-blockchain-world) (2) Sharing
Wed Nov 15	IoT Frameworks	Hamid	(1) Ravel, (2) HomeOS
Mon Nov 20	IoT Security	Ulkuatam	(1) SmartAuth, (2) Electromyography
Wed Nov 22			No class (Thanksgiving)
Mon Nov 27	Misusing Sensors	Agrawal	(1) Gyrophone, (2) PitchIn.

Class	Topic	Lead	Details
	End		
Wed Nov 29	Wrap-up and Future Directions	Campbell	Final papers due Friday.
Mon Dec 4	Project Presentations	All	10 minute talks, 5 min Q&A

Notes for the future!

- Maybe replace LWB with Glossy (or do both). Flooding + network protocol is a lot to cover.
- OS papers were good choices.