ELEN E6920 (F14): Topics in VLSI Systems Design

This is a course that discusses various "hot" topics in VLSI system design. The topic may change semester to semester. The topic for this semester (2014 Fall) is *VLSI architecture for digital signal processing (DSP) applications.* The course consists of largely two parts. The first half of the course will be a lecture series on a number of VLSI architectures. Specific sub-topics that will be covered include:

- Retiming
- Unfolding, folding
- Systolic
- Cordic
- Numerical strength reduction
- Filters
- DFT/FFT processors
- Sub-word single-instruction-multiple-data (SIMD) processors

During the second half of the course, we request 2-3 students to form a group and make an in-depth one-hour presentation on domain-specific DSP architecture. The presentation must focus a single domain application and must discuss (i) mathematical & algorithmic frameworks, (ii) hardware architectures, (iii) important demonstrations and their comparisons. We anticipate the presentation will cover ~20 academic papers in the domain. You can consider this presentation as a mini lecture given to other students in the class. In addition to the topics that you are particularly interested in, the potential topics of the student presentations include:

- Image and video processing: feature extraction, gesture recognition, ultrasound imaging, MRI
- Communication signal processing: channel equalization, Viterbi, LDPC, polar codes, compressive sensing
- Signal processing for bio signals: neural spike sorting, ECG, EEG, ECoG
- Signal processing kernels: FFT, DCT, clustering
- Encryption and decryption: AES, elliptic curve cryptography
- Dynamic system and control: path finding in robot controls

Instructor: Prof. Mingoo Seok (mgseok@ee.columbia.edu)

Teaching Assistant: TBD (@columbia.edu)

Grading: The course has the student presentation which constitutes 50% of the final grade. The term paper accounts for 25% of the final grade, and the peer review submission will take the remaining 25%. Total credit: 3pts

Time/Location:

- Lectures and student presentations (led by the instructor): 10:10am-12:40pm on Wednesday at TBD
- Office hour : Monday 11:30-12:30pm or by appointment (Prof. Seok)

Prerequisites: ELEN E4312, E4810, and CSEE W4823. Students are expected to be familiar with basic digital circuit and logic design and digital signal processing. Backgrounds in machine learning (COMS W4771), computer design (EECS E4340), and advanced VLSI circuit design (EECS E6321) will be useful, but not required.

Text Books: We are primarily using slides but here are several references you may want to use. Most of them are reserved in the library

- Keshab K. Parhi, “VLSI Digital Signal Processing Systems: Design and Implementation,” Willey-Interscience
- Marvine E. Frerking, “Digital Signal Processing in Communication Systems,” Kluwer Academic Publishers

Other References: Below is a partial list of major journals and conferences that cover the topics of this class. You can access these publications and conference proceedings through IEEE Xplore: http://ieeexplore.ieee.org

- Journal of Solid-State Circuits
- Transactions on Very Large Scal e i ntegrati on Systems
- Transactions on Circuits and Systems I: Regul ar Papers
- Transactions on Circuits and Systems II: Express Briefs
- Transactions on Signal Processing
- Journal of Signal Processing Systems (http: //www.springer.com/engineering/signals/journal/11265)
- International Solid-State Circuits Conference (ISSCC)
- Symposium on VLSI Circuits (VLSI)
- Custom Integrated Circuits Conference (CICC)
- Design Automation Conference (DAC)
- International Symposium on Low-Power Electronics and Design (ISLPED)
- International Symposium on Circuits and Systems (ISCAS)
- International Conference on Acoustics, Speech, and Signal Processing (ICASSP)
- Workshop on Signal Processing Systems (SiPS)

Course Websites:

- We will use the CourseWorks (https://courseworks.columbia.edu/) for materials, announcements, assignment submission, and discussions for lectures and student presentation.