Department of Electrical and Computer Engineering

TEXAS TECH UNIVERSITY
Edward E. Whitacre Jr.
College *of* Engineering™

Spring 2024 Seminar Series

Seminar Title: ***A CMOS Molecular Electronics Chip for Single-Molecule Biosensing***

Time: 2:00-2:50 PM, Friday, Jan 26, 2024

Location: Holden Hall 150

Speaker:
Drew Hall
University of California, San Diego

Abstract:
Molecular electronics is the concept of using single molecules as functional circuit elements. This work reports the first CMOS molecular electronics chip. It is configured as a biosensor, where the primary sensor element is a single molecule "molecular wire" consisting of a ~100 GΩ, 25 nm long alpha-helical peptide integrated into a current monitoring circuit. The engineered peptide contains a central conjugation site for attachment of various probe molecules, such as DNA, proteins, enzymes, or antibodies, which program the biosensor to detect interactions with a specific target molecule. The current through the molecular wire under a dc applied voltage. The detected signals are millisecond-scale, picoampere current pulses generated by each transient probe-target molecular interaction. Implemented in a 0.18 µm CMOS technology, 16k pixel circuits are arrayed with a 20 µm pitch and read out at a 1 kHz frame rate. The resulting biosensor chip provides direct, real-time observation of the single-molecule interaction kinetics, unlike classical biosensors that measure ensemble averages of such events. This molecular electronics chip provides a platform for putting molecular biosensing "on-chip" to bring the power of semiconductor chips to diverse applications in biological research, diagnostics, sequencing, proteomics, drug discovery, and environmental monitoring.

Speaker Bio:
Dr. Hall earned a B.S. degree in computer engineering with honors from the University of Nevada, Las Vegas, in 2005, along with M.S. and Ph.D. degrees in electrical engineering from Stanford University in 2008 and 2012, respectively. He has previously held internship positions with General Electric, Bently Nevada Corporation, and National Semiconductor Corporation, where he worked on low-power, precision analog circuit design. He was a research scientist in Intel Labs from 2011 to 2013 in the Integrated Biosensors Laboratory. In 2013, he joined the Jacobs School of Engineering at the University of California, San Diego, where he is currently a full professor in the Department of Electrical and Computer Engineering and an affiliate professor in the Department of Bioengineering. His research interests lie at the nexus of engineering and the life sciences. Specifically, his research group works on bioelectronics, biosensors, analog circuit design, medical electronics, and sensor interfaces. Dr. Hall received the 2011 Analog Devices Outstanding Designer Award and won 1st place in the inaugural international IEEE Change the World Competition and the BME-IDEA invention competition. He received the Hellman Fellowship award in 2014, the ECE undergraduate teaching award in 2014, the prestigious NSF CAREER award in 2015, the NIH Trailblazer award in 2019, and the Best Poster award at BioCAS 2019. He is also a Tau Beta Pi fellow.