Seminar – Wednesday, August 28, in 100A Riggs Hall 3:30 p.m. – 4:30 p.m.

Holcombe Department of Electrical and Computer Engineering Seminar Series

Microwaving a Biological Cell Alive!

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Abstract

The DARPA Spectrum Collaboration Challenge (SC2) is DARPA's fifth grand challenge and is focused on developing breakthrough levels of intelligent, distributed, collaborative spectrum use for networks of radios operating in the increasingly crowded radio-frequency (RF) spectrum. Teams must develop intelligent radio networks that can work in the presence of diverse competitor networks, as well as other users of the RF spectrum, including active and passive incumbents and jammers. Team GatorWings, from the University of Florida, has successfully navigated the challenges in the first two years of the competition, winning prizes totaling $1.5 million. The key to Team GatorWings' success is our highly adaptive and intelligent radio design. In this talk, I will give an overview of the SC2 competition, discuss the technical design of our intelligent radio network, show highlights from the SC2 Preliminary Event 2, and discuss future challenges of intelligent dynamic spectrum access for the SC2 Championship Event and beyond.

Biography of Speaker

Microwave is not just for cooking, smart cars, or mobile phones. We can take advantage of the wide electromagnetic spectrum to do wonderful things that are more vital to our lives. For example, microwave ablation of cancer tumor is already in wide use, and microwave remote monitoring of vital signs is becoming more important as the population ages. This talk will focus on a biomedical use of microwave at the single-cell level. At low power, microwave can readily penetrate a cell membrane to interrogate what is inside a cell, without cooking it or otherwise hurting it. It is currently the fastest, most compact, and least costly way to tell whether a cell is alive or dead. On the other hand, at higher power but lower frequency, the electromagnetic signal can interact strongly with the cell membrane to drill temporary holes of nanometer size. The nanopores allow drugs to diffuse into the cell and, based on the reaction of the cell, individualized medicine can be developed and drug development can be sped up in general. Conversely, the nanopores allow strands of DNA molecules to be pulled out of the cell without killing it, which can speed up genetic engineering. Lastly, by changing both the power and frequency of the signal, we can have either positive or negative dielectrophoresis effects, which we have used to coerce a live cell to the examination table of Dr. Microwave, then usher it out after examination. These interesting uses of microwave and the resulted fundamental knowledge about biological cells will be explored in the talk.

Dr. James Hwang is Professor of Electrical Engineering at Lehigh University. He graduated with a B.S. degree in Physics from National Taiwan University, and M.S. and Ph.D. degrees in Materials Science from Cornell University. After years of industrial experience at IBM, Bell Labs, GE, and GAIN, he joined Lehigh in 1988. He cofounded GAIN and QED; the latter became a public company (IQE). He has been a visiting professor at Cornell University in the US, Marche Polytechnic University in Italy, Nanyang Technological University in Singapore, National Jiao Tong University in Taiwan, Shanghai Jiao Tong University, East China Normal University, and University of Science and Technology in China. He was a Program Officer for GHz-THz Electronics at the US Air Force Office of Scientific Research from 2011 to 2013. He is a Life Fellow of the Institute of Electrical and Electronic Engineers. He has published more than 350 refereed technical papers and been granted eight U. S. patents. He has researched on the design, modeling and characterization of electronic, optical, and micro-electromechanical (MEM) devices and integrated circuits. His current research interest focuses on electromagnetic sensors for individual biological cells, scanning microwave microscopy, and two-dimensional atomic-layered materials and devices.