INVITATION to the
5th Event of the IEEE EMBS Greece Chapter

Distinguished Lecturers Program

Applications of Electromagnetic Engineering in Medicine and Biology

Invited lecture by

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Multimedia Amphitheatre, Central Library Building
National Technical University of Athens, Zografou Campus

Short CV

James Lin is a professor of electrical engineering, bioengineering and physiology and biophysics at the University of Illinois - Chicago, where he has served as Director of Robotics and Automation Laboratory, Head of the Bioengineering Department, and Director of Special Projects in the College of Engineering. He held a NSC Research Chair from 1993-97 and is the author of more than 150 refereed journal papers and author or editor of eight books. He received the B.S., M.S. and Ph.D. degrees in electrical engineering from the University of Washington, Seattle. Dr. Lin has received many professional and scientific awards and recognitions including the d'Arsonval Medal, IEEE Electromagnetic Compatibility Transactions Prize Paper Award, IEEE COMAR Recognition Award, CAPAMA Outstanding Leadership Award, UIC Best Advisor Award. He is an elected Fellow of AAAS, AIMBE, and IEEE. He has served in leadership positions in several engineering, scientific, and professional organizations including President of the Bioelectromagnetics Society, Chairman of the URSI Commission on Electromagnetics in Biology and Medicine, Chairman of the IEEE Committee on Man and Radiation, Vice President of NCRP and Chairman of its Scientific Committee on Biological Effects and Exposure Criteria for Radiofrequency Fields. He is a member of the International Commission on Nonionizing Radiation Protection (ICNIRP), serves on several journal editorial boards and is Editor-in-Chief of the Bioelectromagnetics journal. He was a member of U.S. President's Committee on the National Medal of Science.

Abstract

Advances of scientific knowledge in the interaction of electromagnetic (EM) fields with biological systems are prompting new approaches for using electromagnetic energy in medicine and biology. This presentation will discuss uses in thermal ablation therapy and diagnostic imaging and sensing, where antenna systems are employed to deliver and receive EM energy from the target tissue both outside and inside the human or animal body. Minimally invasive catheter ablations have become important therapies for cancer and for selected patients with drug refractory, symptomatic supraventricular tachyarrhythmias. For example, microwave catheter antennas have been used to radiate electromagnetic waves into endocardiac tissue. Ablation of the atrioventricular (AV) junction with microwave catheter antennas has become an accepted standard treatment. Wireless EM energy at a broad range of frequencies is increasingly being proposed for sensing and imaging in biomedical scenarios. When a wireless signal in the high frequency range impinges on a biological target, reflections can take place at tissue boundaries to allow tissue imaging. In addition, the signal experiences a Doppler phenomenon which shifts the signal either up or down from that of the impinging frequency. It provides a convenient technique to sense and monitor organ movements without compromising the integrity of the physiological events and a capability for continuous monitoring as well as quantifying time-dependent changes in the cardiopulmonary systems during the cardiac cycle. Doppler microwaves have been employed to interrogate the pressure pulse characteristics at a variety of arterial sites, including the carotid, brachial, radial and femoral arteries. Microwave-sensed carotid pulse waveforms have been obtained in patients using contact application of 25 GHz energy along with simultaneously recorded intra-aortic pressure waves. The resemblance of the microwave-sensed arterial pulse and the invasively recorded pressure wave is remarkable. These results confirm that a noninvasive wireless sensor can successfully and reproducibly detect pressure pulse waveforms of diagnostic quality.

Imaging is a powerful tool not only for the visualization, but also for the quantification of fundamental and complex biological processes. In this presentation, we will discuss how the principles of signal detection and quantitative imaging can be applied to preclinical research. Furthermore, we will also demonstrate examples of successful implementation of new ideas in this rich field, for the imaging of preclinical models of disease.