Visiting Faculty Lecture

11am Friday, November 7, 2014
Barus & Holley 751, Brown University School of Engineering

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Model-based design of devices and treatment delivery strategies for image-guided thermal therapy

Abstract
Image-guided thermal ablation has shown promising results and gained clinical acceptance for treatment of cancer and benign disease. Ablation treatments entail localized energy deposition for complete thermal destruction (T > 55 °C) of the targeted tissue, while minimizing thermal damage to adjacent critical structures. Several phase III clinical trials have demonstrated the benefits of using local hyperthermia (moderate heating, 39-45 °C) as an adjuvant to radiation and/or chemotherapy. Besides cytotoxicity, thermal therapies may induce a number of biological and physiological effects including: inhibiting the repair of radiation induced DNA damage, changes in tumor perfusion and oxygenation, a heat shock response, and the immune response. To successfully harness the potential of thermal therapies, systems capable of localized, controlled heating need to be developed for inducing desired transient temperature profiles.

Theoretical models of energy deposition and bioheat transfer provide a powerful tool for the design and optimization of novel devices, treatment delivery strategies, and patient-specific treatment planning platforms. This presentation will review theoretical models of electromagnetic energy deposition, bioheat transfer, and techniques for modelling the biological response to heating. Application of numerical models to the design of novel devices, feedback-controlled treatment delivery strategies, and predictive treatment planning will be presented. Integration with imaging systems and estimation of patient-specific physical and physiological parameters to enhance patient-specific treatment planning will be discussed. Preliminary results exploring the feasibility of employing nano-material electromagnetic contrast agents to enhance the efficacy of microwave ablation procedures will be presented.

Speaker Biography

Punit Prakash is an Assistant Professor in the Department of Electrical and Computer Engineering at Kansas State University. He obtained the B.S. (2004) degree in Electrical and Computer Engineering from Worcester Polytechnic Institute and the Ph.D. (2008) degree in Biomedical Engineering from the University of Wisconsin-Madison. From 2008-2012, he did research on ultrasound and microwave technologies (device design, patient-specific treatment planning) for image-guided cancer thermal therapy at the University of California, San Francisco. Since August 2012, Dr. Prakash has been at KSU where he directs research in the Biomedical Computing and Devices Laboratory. His areas of research interest include technologies for image-guided thermal therapy, electromagnetic energy-tissue interactions, and bioinstrumentation.

Hosts
Derek Merck and Damian Dupuy, Rhode Island Hospital Diagnostic Imaging
Benjamin Kimia, Brown University Engineering