Microwave Near-field Imaging of Human Tissue: Hopes, Challenges, Outlook

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Abstract: More than 40 years ago, Larsen and Jacobi experimented with microwaves in the imaging of canine kidney. Their pioneering work triggered high hopes for a new diagnostic modality in medicine but also identified serious challenges. Research effort in this area continues unabated, focused especially on early-stage breast-cancer detection. The need for alternative cancer diagnostic tools is urgent and perceived worldwide as a high priority for research and development. Yet the very few clinical trials of experimental microwave imaging systems have not satisfied the requirements of today’s medical diagnostics. This talk briefly reviews past and recent developments in near-field microwave methods for tissue imaging. In the context of these developments, the major challenges are discussed – challenges which have so far prevented microwave imaging from becoming a clinically viable modality. Promising new directions of research are described that have the potential to bring about a breakthrough. These include advances in hardware design and characterization (sensor arrays, custom and laboratory measurement instrumentation), methodologies for tissue-parameter characterization, and the development of data-processing and reconstruction algorithms. Many of these new developments draw upon recent successes of microwave and millimeter-wave imaging systems used for concealed-weapon detection, through-the-wall imaging and underground surveillance. Thus it is shown how the ever expanding field of microwave imaging is converging to address some of society’s most urgent needs.

Bio: In July 1999, Natalia K. Nikolova joined the Department of Electrical and Computer Engineering, McMaster University, where she is currently a Professor. Her research interests include theoretical and computational electromagnetism, microwave imaging with applications in biomedical diagnostics and concealed weapon detection, nondestructive testing and security, as well as algorithms for computer-aided high-frequency design. She has published more than 85 papers in engineering and physics journals, and has contributed to more than 115 refereed conferences in the fields of microwave and antenna engineering, electromagnetic theory, numerical methods, etc. Dr. Nikolova held a University Faculty Award of NSERC from 2000 to 2003, renewed to 2005. Since 2008, she is a Canada Research Chair in High-frequency Electromagnetics. She is a Fellow of the IEEE and a member of the Microwave Theory and Techniques Society and the Antennas and Propagation Society.