IEEE I&M Society New Zealand Chapter Seminar cum Distinguished Lecturer Visit

Title: Microwave and Millimeter Wave Imaging for NDE Applications

– Past, Present and Future

Presenter: Professor Reza Zoughi
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Date	Time	Venue	Contact Person
19th April 2011	1 pm to 3pm	Auckland University of Technology, Auckland Room: **WF303, AUT, Auckland [corner of Wakefield St & Mayoral Drive]**	Akbar Ghobakhlou akbar@aut.ac.nz
20th April 2011	12 pm to 2pm	Massey University, Palmerston North Room: **AH 2 (AG-HORT Lecture Block)**	Subhas Mukhopadhyay s.c.mukhopadhyay@massey.ac.nz
21st April 2011	2 pm to 4 pm	Industrial Research Limited, Lower Hutt Room: : Alan MacDiarmid Centre, IRL, Lower Hutt	Keith Jones K.Jones@irl.cri.nz

Abstract: Millimeter-wave signals span the frequency range of 30 GHz to 300 GHz, corresponding to a wavelength range of 10 mm to 1 mm. Signals at these frequencies can easily penetrate inside dielectric materials and composites and interact with their inner structures. The relatively small wavelengths and wide bandwidths associated with these signals enable the production of high spatial-resolution images of materials and structures. Incorporating imaging techniques such as lens-focused and near-field techniques, synthetic aperture focusing, holographical methods, robust back-propagation algorithms with more advanced and unique millimeter wave imaging systems have brought upon a flurry of activities in this area and in particular for non-destructive evaluation (NDE) applications. These imaging systems and techniques have been successfully applied for a wide range of applications including:

∗ detection and evaluation of corrosion under paint,

∗ inspection of the space shuttle external fuel tank spray-on foam insulation (SOFI) and acreage heat tiles for interior flaw and corrosion detection and evaluation,

∗ inspection of layered composites such as radomes and control surfaces for interior flaws and moisture ingress, and

∗ detection and evaluation of disbond in carbon fiber-reinforced polymer (CFRP) retrofitted concrete bridge members.

Near-field techniques have been prominently used for these applications. However, undesired issues related with changing standoff have resulted in several innovative and automatic standoff distance variation removal techniques. Ultimately, imaging techniques must produce high resolution (in 3D) images, become real-time, and use portable systems. To this end and to expedite the imaging process while providing a high-resolution images of a structure, recently the design and demonstration of a 6" by 6" one-shot, rapid and portable imaging system (Microwave Camera), consisting of 576 resonant slot elements, was completed. Currently, efforts are being expended to enable mono-static imaging and increasing its operating frequency into higher millimeter wave frequencies. This presentation provides an overview of these techniques, along with illustration of several typical examples where these imaging techniques have effectively provided viable solutions to many critical problems.

Presenter: R. Zoughi received his B.S.E.E, M.S.E.E, and Ph.D. degrees in electrical engineering (radar remote sensing, radar systems, and microwaves) from the University of Kansas where from 1981 until 1987 he was at the Radar Systems and Remote Sensing Laboratory (RSL). Subsequently, in 1987 he joined the Department of Electrical and Computer Engineering at Colorado State University (CSU), where he established the Applied Microwave Nondestructive Testing Laboratory (*amntl*). He held the position of *Business Challenge Endowed Professor of Electrical and Computer Engineering* from 1995 to 1997 while at CSU. In 2001 he joined the Department of Electrical and Computer Engineering at Missouri University of Science and Technology (S&T), formerly University of Missouri-Rolla (UMR), as the *Schlumberger Distinguished Professor*. His current areas of research include developing new nondestructive techniques for microwave and millimeter wave testing and evaluation of materials (NDT&E), developing new electromagnetic probes and sensors to measure characteristic properties of material at microwave frequencies, developing embedded modulated scattering techniques for NDT&E purposes and real-time high resolution imaging system development. He is the author of a textbook entitled "*Microwave Nondestructive Testing and Evaluation Principles*" KLUWER Academic Publishers, 2000, and the co-author with A. Bahr, and N. Qaddoumi of a chapter on Microwave Techniques in an undergraduate introductory textbook entitled "*Nondestructive Evaluation: Theory, Techniques, and Applications*" edited by P.J. Shull, Marcel and Dekker, Inc., 2002. He has been the recipient of numerous teaching awards both at CSU and Missouri S&T. He is the co-author of over 455 journal papers, conference proceedings and presentations and technical reports. He has ten patents to his credit all in the field of microwave nondestructive testing and evaluation. He was the recipient of the 2007 recipient of the IEEE Instrumentation and Measurement Society *Distinguished Service Award*, the 2009 American Society for Nondestructive Testing (ASNT) *Research Award for Sustained Excellence*, and the 2011 *IEEE Joseph F. Keithley Award in Instrumentation & Measurement*. He is a *Fellow* of the Institute of Electrical and Electronics Engineers (IEEE), a *Fellow* of American Society for Nondestructive Testing (ASNT), and the Editor-in-Chief of the *IEEE Transactions on Instrumentation and Measurement*. For more information please see

http://amntl.mst.edu/people/zoughi.html and http://amntl.mst.edu/.