UNIVERSITY OF CALGARY
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

SCHULICH School of Engineering — UNIVERSITY OF CALGARY

Development of the free-space metamaterial 'superlens'

Speaker: Ashwin Iyer, University of Alberta

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Focusing using conventional lenses relies on the collection and interference of propagating waves, but discounts the evanescent waves that decay rapidly from the source. Since these evanescent waves contain the finest details of the source, the image suffers a loss of resolution and is referred to as 'diffraction-limited'. 'Superlensing' is the ability to create an image with fine features beyond the diffraction limit, and can be achieved with a superlens made from a metamaterial possessing a negative refractive index. To image in free space, such a superlens must be stringently designed to restore both propagating and evanescent waves, but meeting these design conditions has proven difficult and has made its realization elusive.

The University of Toronto Electromagnetics Group has been involved with metamaterials research since 2001, and introduced the negative-refractive-index transmission-line (NRI-TL) metamaterial approach, in which a host medium is periodically loaded using inductors and capacitors to synthesize exotic effective material properties like a negative permittivity, negative permeability, and a negative refractive index. The use of reactive loading and established transmission-line techniques enables precise control over these properties, and so the NRI-TL concept was applied to the elusive goal of realizing the free-space metamaterial superlens.

Following a brief overview of the field of metamaterials and a discussion on the development of the NRI-TL concept, I'll describe the design and experimental realization of a free-space metamaterial superlens based on the NRI-TL metamaterial concept. This device has demonstrated imaging in free space with a resolution over three times better than the diffraction limit at 2.4GHz. A microwave superlens can be particularly useful for illumination and discrimination of closely spaced buried objects over practical distances by way of back-scattering, e.g. in tumour or landmine detection, or for targeted irradiation/hyperthermia.

Ashwin K. Iyer received the BASc., MASc., and Ph.D. degrees in electrical engineering from the University of Toronto, Ontario, Canada, in 2001, 2003, and 2009 respectively. He joined the faculty of the University of Alberta Department of Electrical and Computer Engineering in the fall of 2009. In 2008, Ashwin was the recipient of the R.W.P. King Award, presented by the IEEE Antennas and Propagation Society to an author less than 36 years of age for the best paper published in the IEEE Transactions on Antennas and Propagation during the previous year.

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