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Friday, 10th November, 2017
10.00 am – 11.00 am
Seminar Room 149, Level 1, Building E6B
Macquarie University, Sydney

Multifocal Bootlace Lens Design Concepts

Reflectors and lenses provide two optical mechanisms to magnify small apertures. They also provide limited scanning of the narrow beams that are produced by the magnified aperture. In both cases, scanning is achieved by switching the feed element location. However, there are a number of basic differences between the two structures. While the reflector system is less complex then the lens, it may occupy more volume for the same features and may suffer from blockage losses. The reflector has a single perfect focal point where secondary radiation has a planar phase front. Other elements in the feed array produce non-planar wave fronts or planar fronts with significant phase variations. The bootlace or Rotman lenses, on the other hand, have three multiple-element radiating structures, and offer more degrees of freedom that help in realizing multiple focal points. The three radiating structures are the feed array, the receiving array on one side of the lens, and the radiating array on the other side of the lens. The traditional bootlace lens is two dimensional, with feed points, receiving, and transmitting arrays all lying on a plane. While this provides for easy strip-line or printed circuit fabrications, there is no physical restriction from extending the formulations to three-dimensional structures.

The degrees of freedom in a bootlace lens include the feed element locations and the transmission line lengths between the receiving and radiating sides of the lens. These allow for choosing a simple planar array surface on the radiating side and for optimizing the parameters to produce multiple perfect focal points with little phase errors for points that fall in between the perfect foci. The optimization process, aiming at increasing the number of focal points and minimizing the phase errors at other points, has produced lens designs with two to five focal points. Some of these are: the 2-dimensional Rotman Lens, with a straight radiating aperture and three perfect focal source points; the Planar McGrath Lens, with straight inner surface as well and two focal points; the Rao Bifocal Lens with two focal points, the Quadrufocal Lens, with four perfect focal points, and the three-dimensional Quintafocal Lens which can scan beams in two dimensions. These lens configurations offer a broadband, high performance alternative to reflector antennas.

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Carey M. Rappaport (IEEE M, SM 96, F 06) received five degrees from the Massachusetts Institute of Technology: the SB in Mathematics, the SB, SM, and EE in Electrical Engineering in June 1982, and the PhD in Electrical Engineering in June 1987. He is married to Ann W. Morgenthaler, and has two children, Sarah and Brian.

Prof. Rappaport has worked as a teaching and research assistant at MIT from 1981 until 1987, and during the summers at COMSAT Labs in Clarksburg, MD, and The Aerospace Corp. in El Segundo, CA. He joined the faculty at Northeastern University in Boston, MA in 1987. He has been Professor of Electrical and Computer Engineering since July 2000. In 2011, he was appointed College of Engineering Distinguished Professor. During fall 1995, he was Visiting Professor of Electrical Engineering at the Electromagnetics Institute of the Technical University of Denmark, Lyngby, as part of the W. Fulbright International Scholar Program. During the second half of 2005, he was a visiting research scientist at the Commonwealth Scientific Industrial and Research Organisation (CSIRO) in Epping Australia. He has consulted for CACI, Alion Science and Technology, Inc., Geo-Centers, Inc., PPG, Inc., and several municipalities on wave propagation and modeling, and microwave heating and safety. He was Principal Investigator of an ARO-sponsored Multidisciplinary University Research Initiative on Humanitarian Demining, Co-Principal Investigator of the NSF-sponsored Engineering Research Center for Subsurface Sensing and Imaging Systems (CenSSIS), and Co-Principal Investigator and Deputy Director of the DHS-sponsored Awareness and Localization of Explosive Related Threats (ALERT) Center of Excellence.

Prof. Rappaport has authored over 430 technical journal and conference papers in the areas of microwave antenna design, electromagnetic wave propagation and scattering computation, and bioelectromagnetics, and has received two reflector antenna patents, two biomedical device patents and four subsurface sensing device patents. He was awarded the IEEE Antenna and Propagation Society's H.A. Wheeler Award for best applications paper, as a student in 1986. He is a member of Sigma Xi and Eta Kappa Nu professional honorary societies.

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