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### NIRMALA RAMANUJAM, ASSOCIATE PROFESSOR



Dr. Ramanujam's research interests include optical spectroscopy, optical sectioning microscopy and photon migration techniques. Her research group is developing and applying these optically based tools for the non-invasive characterization of the biochemical and structural properties of human tissues. These technologies are being specifically engineered for the early detection of breast and cervical cancers.



Technologies based on light have the potential to revolutionize early detection for cancer. Light is safe (non-ionizing radiation) and low cost compared to existing diagnostic modalities such as mammography and magnetic resonance imaging (MRI). Light is unique in that it can unravel physiological, metabolic and structural properties of cancer by interacting with a large number of biological molecules that are already present in the tissue. Light can also be used to detect optically labeled probe molecules (antibodies, peptides, etc) that specifically bind to over expressed molecular targets in cancer cells within the tissue. Additionally, these intrinsic and extrinsic sources of optical contrast can be detected rapidly and non-destructively from human tissues in vivo using low power light sources, fiber optic delivery and collection systems and semiconductor detectors. Thus, compelling reasons exist to exploit light based technologies to aid in the clinical diagnosis of cancer.

Our group works on a broad range of research activities to develop optical systems for the clinical detection of cancer. We develop and use stochastic modeling techniques to describe the basic physics of light propagation in turbid media such as tissue. Understanding light propagation in tissue is essential for designing optical systems and algorithms for tissue spectroscopy and imaging. Our group also engineers optical systems including specialized fiber-optic probes for in vivo optical spectroscopy. Additionally, we actively pursue the development of mathematical algorithms for feature extraction and classification of the spectroscopic signals. We validate the effectiveness of our technologies through optical microscopy studies of cell and tissue culture models, small animal imaging and in actual clinical trials. The latter studies are done collaboratively with investigators in the biological and clinical sciences. Our research is currently funded by the NCI, NIBIB and DOD.

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#### Education:

PhD, University of Texas, Austin, 1995  
MS, University of Texas, Austin, 1992  
BS, University of Texas, Austin, 1989

#### Specialties:

Medical Imaging  
Photonics  
Cancer diagnostics and therapy  
Medical Instrumentation  
Medical Diagnostics

#### Research Interests:

Ramanujam's research interests include optical spectroscopy, optical sectioning microscopy and photon migration techniques. Her research group is developing and applying these optically based tools for the non-invasive characterization of the biochemical and structural

properties of human tissues.

#### Awards, Honors, and Distinctions

Fellow, American Society for Laser Medicine and Surgery, January, 2007  
Era of Hope Scholar Award, DOD Breast Cancer Research Program, 2005  
Global Indus Technovators Awards, Indian Business Club at MIT, 2005  
Technology achievement award, MIT Alumni Association of Wisconsin, 2005  
Vilas Associate award, University of Wisconsin, Madison, 2005  
Invited speaker, Gordon Conference on Lasers in Medicine and Biology, 2004  
TR100 Young Innovator Award, Selected as one of the top 100 young innovators in technology in the world by MIT's Technology Review Magazine, 2003  
Whitaker travel award to participate in the ASEE Conference, 2002  
Whitaker Foundation investigator, 2001  
Invited participant in NSF's "Engineering Education Scholars Workshop", 1996  
National Research Service Award, National Institutes of Health, 1996  
One of three finalists in the American Association for Medical Instrumentation Young Investigator Competition, 1996  
Scholarship, Association for Women in Science Educational Foundation, November, 1995  
Award for Best Scientific Paper, American Association of Cancer Research, 1995  
Summer Research Scholarship, American Society for Laser Medicine & Surgery, 1995  
Scholarship, International Society for Optical Engineering, November, 1994  
Award for Best Scientific Paper, American Society for Laser Medicine & Surgery, 1994-95  
Professional Development Award, University of Texas, Austin, 1994-95  
Competitive Academic Fellowship, University of Texas, Austin, 1991

#### Recent Publications [\(More Publications\)](#)

1. J. E. Bender and K. Vishwanath and L. K. Moore and J. Q. Brown and V. Chang and G. M. Palmer and N. Ramanujam, *A Robust-Monte Carlo Model for the Extraction of Biological Absorption and Scattering In Vivo*, Ieee Transactions On Biomedical Engineering, vol. 56 no. 4 (April, 2009), pp. 960 -- 968 [[abs](#)].
2. J. Q. Brown and L. G. Wilke and J. Geradts and S. A. Kennedy and G. M. Palmer and N. Ramanujam, *Quantitative Optical Spectroscopy: A Robust Tool for Direct Measurement of Breast Cancer Vascular Oxygenation and Total Hemoglobin Content In vivo*, Cancer Research, vol. 69 no. 7 (April, 2009), pp. 2919 -- 2926 [[abs](#)].
3. J. Q. Brown and K. Vishwanath and G. M. Palmer and N. Ramanujam, *Advances in quantitative UV-visible spectroscopy for clinical and pre-clinical application in cancer*, Current Opinion In Biotechnology, vol. 20 no. 1 (February, 2009), pp. 119 -- 131 [[abs](#)].
4. J. Y. Lo and B. Yu and H. L. Fu and J. E. Bender and G. M. Palmer and T. F. Kuech and N. Ramanujam, *A strategy for quantitative spectral imaging of tissue absorption and scattering using light emitting diodes and photodiodes*, Optics Express, vol. 17 no. 3 (February, 2009), pp. 1372 - 1384 [[abs](#)].
5. J. Q. Brown and T. M. Bydlon and S. A. Kennedy and L. Richards and M. S. Junker and G. M. Palmer and J. Geradts and L. G. Wilke and N. Ramanujam, *Intraoperative optical breast tissue characterization device for tumor margin assessment*, Cancer Research, vol. 69 no. 2 (January, 2009), pp. 101S -- 101S .

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