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STEVENS INSTITUTE OF TECHNOLOGY
DEPARTMENT OF MECHANICAL ENGINEERING

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Carnegie Bldg, Room 315, Time 1:30 pm

3D optics

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In 3D optical elements, light interacts with the element throughout its entire volume (as opposed to discrete set of surfaces, which is done in traditional optics.) This allows for more degrees of freedom in shaping the optical response, in particular creating shift-variant responses. We have used this property in a number of ways to acquire 3D object information from both reflective and fluorescent objects under a variety of illumination conditions, including laser-line-scan, rainbow and uniform white light. The key benefits of using 3D optics are summarized as excellent resolution over long working distances, reduced or completely eliminated scanning, and simultaneous spectral imaging. Our research addresses the physics of 3D optical elements, their fabrication, and computational methods for maximal information extraction from 3D optical imaging systems. In the area of computation, we have emphasized the use of maximum-likelihood principles, in particular the Viterbi algorithm, to improve resolution by at least a factor of 5 relative to the classical limit. In the area of fabrication, we have developed the Nanostructured Origami™ fabrication and assembly method for nanomanufacturing macro-scale optical systems which also include sub-wavelength optical elements and non-optical components, e.g. energy storage. In this talk, we will summarize the results of our work on 3D optics and argue that the combined optimization of physics, fabrication and computation is the most promising for future imaging systems.

Professor George Barbastathis received the Electrical and Computer Engineer's degree from the National Technical University of Athens in 1993, and the M.Sc. and Ph.D. in Electrical Engineering from the California Institute of Technology in 1994 and 1997, respectively. After post-doctoral work at the University of Illinois, Urbana-Champaign, he joined the faculty at the Massachusetts Institute of Technology in 1999, where he is currently Associate Professor in the Mechanical Engineering Department. Dr. Barbastathis' research group works on information photonics, i.e. the use of new optical physics and engineering design methods towards utilizing light in information processing, in particular sensing/imaging and nanofabrication. The unifying theme of Prof. Barbastathis' research is the use of the 3rd dimension for optical information processing, for example 3D spatial heterodyning for simultaneous high-resolution 3D spatial and spectral imaging, and Nanostructured OrigamiTM, a method for 3D fabrication and assembly using exclusively 2D litho tools. His past research accomplishments include the holographic method of shift multiplexing, an interferometric corneal topographer, volume holographic confocal microscopy, resonant holography, and the first-ever real-time four-dimensional (spatial and spectral) optical microscope. Dr. Barbastathis is presently serving as Topical Editor for the Journal of the Optical Society of America A.