BIOLOGICALLY INSPIRED SENSING AND IMAGING OF POLARIZATION INFORMATION IN NATURE

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When we view the world with unaided eyes, two of the characteristics of image-forming visible light from the scene, namely, the intensity and the wavelength, are detected by our visual system, and then are encoded into perceptual qualities of brightness and color. Our eyes, however, cannot gather and use the information about the third physical characteristic of light, its polarization, and are thus blind to this important component of optical signals. It is well known, however, that several species of animals have visual systems capable of detecting lights polarization and using the information so extracted (see e.g., R. Wehner, Matched filters neural models of the external world, J. Comp. Physiol. A, Vol. 161, pp. 511-531, 1987). These species typically use this ability for navigation. However, it is believed that some species may also use polarization information to enhance in detecting predators and prey and in breaking camouflage.

We believe that much can be learned from polarization vision in nature, and indeed we have introduced and developed various imaging algorithms, sensing schemes and visualization and display methodologies inspired and informed by biological consideration (see e.g., K. M. Yemelyanov, S.-S. Lin, W. Q. Luis, E. N. Pugh, Jr., and N. Engheta, Bio-Inspired Display of Polarization Information Using Selected Visual Cues, the 2003 SPIE-The International Society for Optical Engineering, Volume 5158 (the Polarization Science and Remote Sensing), San Diego, California, August 3-8, 2003, pp. 71-84). Our ongoing research efforts demonstrate that these bio-inspired polarization sensing and imaging techniques facilitate better target detection, enhanced visibility in otherwise low-contrast conditions, longer detection range in optically scattering media, man-made polarization-sensing adaptation based on changing environments, surface deformation/variation detection (e.g., detection of finger prints on a smooth surface using polarization-based vision), shadow removal by displaying polarization information instead of conventional intensity information, and many more novel outcomes. These results show the numerous possibilities and potential applications of these bio-inspired methods in various sensing, imaging, and display technologies. In this talk, we will present an overview of some of the various aspects of our research efforts in this area.

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2. K - Electromagnetics in Biology and Medecine

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4. I - Invited Paper, Program chair: Gianluca Lazzi

5. Please send this abstract to Professor Gianluca Lazzi in Commission K.