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Piscataway, NJ – December 2, 2014 – Biological insights have the potential to transform technical endeavors, particularly when it comes to vision and imaging technology. Proceedings of the IEEE, the most highly cited general interest journal in computer and electrical engineering, and computer science, explores this, and other topics, in a recent issue on bioinspired imaging. This special issue highlights progress and continuing efforts in the domain of vision and biological optics.

In recent decades, we’ve seen remarkable growth in academic disciplines and research specialties such as biomedical engineering, robotics, neuromorphic systems design, biomaterials, and biofabrication, all of which rely on the transformative role of biology as a key partner for interdisciplinary progress. In this special issue, you will find a focus on how animals make use of sensory information. Biological systems that process visual information are as varied and unpredictably complex as their long histories of evolutionary development, and that calls for in-depth examination.

The special issue of Proceedings of the IEEE presents a selection of papers tied together by their link to technical innovation and biology. Some of those papers include the following:

“The Remarkable Visual Abilities of Nocturnal Insects: Neural Principles and Bioinspired Night-Vision Algorithms,” by E. Warrant, M. Oskarsson, and H. Malm. The ability to see at night ought to be abysmally poor in the Central American bee, Megalopta genalis, because its apposition compound eyes do not combine photons from many directions. Yet, in defiance of its apparently inadequate lens system, this insect navigates superbly under dark forest cover. This Lund University, Lund, Sweden, research, led by Eric Warrant, explains the adaptations that enable Megalopta to be a highly competent night flyer, including amplification at the photoreceptor response and neural circuits that boost spatio-temporal summation and suppress noise. The authors use limitations in the detection reliability of nocturnal eyes as a starting point to demonstrate a method for enhanced night-vision video, with preserved color.

“Detecting 3-D Mirror Symmetry in a 2-D Camera Image for 3-D Shape Recovery,” by T. Sawada, Y. Li, and Z. Pizlo. This research, based at Purdue University, West Lafayette, Indiana, adopts a theory of human visual perception to construct 3-D representations of natural scenes. The construction relies on discovering how human vision solves an inverse problem: Given a 2-D image at the retina, induce the correct layout of shapes and objects in external 3-D space that gave rise to it. Without bounding constraints, there are infinitely many
solutions, so the problem is ill posed. The authors, Tadamasa Sawada, Yunfeng Li, and Zygmunt Pizlo, find these constraints in human perceptual analysis, sufficient for robotic 3-D constructions to match human vision. This paper presents new formal results and applies them to infer 3-D shapes from a camera image.

“Bioinspired Visual Motion Estimation,” by G. Orchard and R. Etienne-Cummings. Garrick Orchard and Ralph Etienne-Cummings review how motion sensing is understood in visual biology. The authors, from the Johns Hopkins University, Baltimore, Maryland, and the National University of Singapore, Singapore, trace the historical development of models for motion detection and classification. Thirty-four published approaches are compared, and most rely on a method of contrast or edge detection in the spatial or temporal domain. The authors discuss a new method using layers of spiking neurons, and suggest significant problems of neuromorphic design that still await solution.


Guest editors for this issue include Willard Larkin, Ph.D., emeritus advisor to U.S. Air Force Office of Scientific Research; IEEE Fellow Ralph Etienne-Cummings, Ph.D., who is a professor and chairman of the Department of Electrical and Computer Engineering with Johns Hopkins University in Baltimore, Maryland; and IEEE Fellow Jan Van der Spiegel, Ph.D., who is a professor of electrical and systems engineering and the director of the Center for Sensor Technologies at the University of Pennsylvania, Philadelphia.

To learn about all of these concepts, and more, visit the Proceedings of the IEEE website.

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