
Scale-Dependent Processing of Clustered Sensory Signals
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Mark E. Nelson
University of Illinois, Urbana-Champaign

Albert S. Feng
University of Illinois, Urbana-Champaign

Narendra Ahuja
University of Illinois, Urbana-Champaign

In natural environments, sensory signals often arise from clustered sources. For example, during the mating season, the auditory cues that guide a female frog to a particular male are embedded in a dense chorus arising from hundreds of calling males of different species. Clustered signals pose a significant challenge for biological systems as well as for intelligent neural prostheses and machine perception systems. For example, an intelligent hearing aid should exhibit robust performance in cluttered environments with other voices in the background. A multidisciplinary team of investigators will explore the neural mechanisms and computational algorithms that animals use to detect, identify, and localize individual signals embedded in an ensemble of similar signals. Experimental studies will focus on the auditory-mediated approach of female frogs to a mating chorus and the electrosensory-mediated approach of electric fish to a cluster of prey. These studies will include audio recordings of frog choruses at different distances from natural mating ponds and electrical recordings of active electrosensory signals arising from swarms of zooplankton. Approach trajectories will be recorded and analyzed using radio telemetry (frogs) and infrared video recordings (fish, frogs). Theoretical analysis will draw on algorithms from computer vision including multiscale grouping and segmentation, target detection and tracking, active vision, texture analysis, and motion and structure estimation. Neural correlates of clustered signal processing will be assessed through electrophysiological studies on auditory nerve and midbrain neurons in frogs and primary electrosensory afferent and hindbrain neurons in fish. This project will incorporate interdisciplinary training (engineering and neurobiology) for students, a web site for sharing data, software and references in this field and could contribute to the development of improved machine devices for speech recognition and video surveillance.

Project (or PI) Website

http://nelson.beckman.uiuc.edu/