Monday 3:00 — 5:00 PM: Early Vision and High-Level Visual Perception - Special Minisymposium — Paper Presentation, Opera House

1035 — 3:30

TEXTURE PERCEPTION: FILTERS, NON-LINEARITIES AND STATISTICS (D.R. Bergen) David Sarnoff Research Center, Princeton, USA.

Visual texture perception has been thought for many years to be a possible link between low-level visual processes that are studied using physiological and psychophysical methods and higher-order processes with more direct perceptual manifestations. In this view, textures are treated as random spatial processes with specified spatial correlation properties. One difficulty with this approach is that explicit description of complex spatial statistics is awkward. The second approach treats texture as a random scattering of some set of small local features. In this case, it is the structure of these local features that captures the spatial correlation properties of the texture. One difficulty with this approach is that it is hard to know how to define local features that are appropriate and can be extracted reliably from natural images.

The statistical and feature-based approaches can be united into a single framework in which the central description is in the set of histogram or first-order statistics of the output of a set of local spatial measurements. On the basis of this description, it is possible to synthesize textures matching given examples in the sense that their filter output histograms are matched. This allows a direct test of the sufficiency of a hypothesized local spatial representation.

1036 — 4:00

SECOND-ORDER PERCEPTION

(George Sperling) University of California, Irvine, CA 92717.

As an ideal way to detect a pattern is make a template of the pattern, correlate the input with the template, and output a detection response when the correlation exceeds a threshold. This basis is the linear-filter-plus-threshold approach that has worked as well for some psychophysical phenomena, a regime referred to as first-order perception. However, as soon as there is uncertainty in location, size, shape, orientation, shading, or any other characteristic, both the ideal statistical and actual human detection problems are enormously more complex. For some cues in which the ideal solution is known, it involves highly nonlinear combinations of elementary filters. Method. An enormously useful tool for the study of such complex perceptual processes is the use of stimulus patterns that cannot detected by a linear-filter-plus-threshold mechanism. Second-order perception refers to the ability to perceive structure in such patterns. The essential ingredient is human 2nd-order perception seems to be full-wave rectification (e.g., absolute value or squaring) of the output of "better grubbies." What is surprising is that such highly nonlinear rectification processes seem both to be pervasive and to occur extremely early in perception. Demonstrations of 2nd-order phenomena will illustrate lateral inhibition specific to spatial frequency. Much of this 2nd-order stimulus information and motion information occurs monocularly (before binocular combination) as well as interocularly. Whereas 2nd-order stimuli, by their nature, are less information-dense than first-order stimuli, the statistical efficiency with which they are detected rival that of first-order stimuli. Conclusion. The universality, primiveness, and efficiency of second-order perceptual phenomena suggests that feature extraction and rectification are basic computations in visual perception that occur at or earlier in processing levels.


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1037 — 4:30

Visual surface representation: an intermediate stage between early filtering and object recognition.

(Ken Nakayama and Zhiqiang Hei, Harvard University: (Shinsuke Shimojo), University of Tokyo

We divide this presentation into two sections. First, in a series of visual tasks traditionally thought to be mediated by early filtering, we show a strong dependence of higher order factors, primarily organization at a surface representation level. Thus motion perception, visual search, and visual texture segregation are shown to be critically dependent on the observed surface layout, not the presumed outputs of cortical filters. This suggests that one must either consider surface representation to be implemented earlier in the visual pathway, or than had been previously supposed and/or that so-called rapid visual processes are implemented later.

Second, we have attempted to understand the mechanism of surface formation itself. Again, rather than appealing to early filtering, we propose local interactions among visual modules that are highly constrained by real world inverse optics rules. This includes local T-junctions, binocular disparity and half occlusions, border offsetting, and the evaluation of the Metelli transparency conditions. Many of these can in part be understood in terms of the generic sampling assumption. The visual system assumes that it is not viewing the scene from a privileged vantage point.

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