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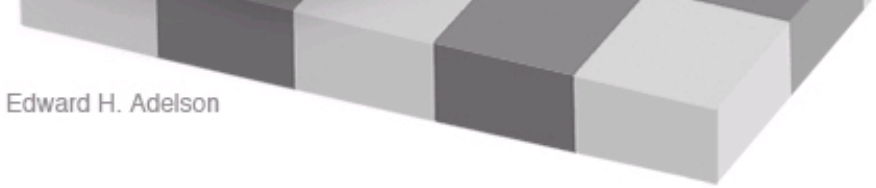
Visual Psychophysics and Computational Vision

We study various problems in visual perception, from the standpoints of both human vision and computer vision. Current topics involve "mid-level" visual processing, including perceptual organization, as applied to motion, transparency, lightness, and texture. We are also studying the perception of materials, i.e., how it is that we can tell that something is shiny or translucent, or that it is made of plastic or metal. In much of our work, the we are interested how humans (and machines) can utilize image statistics (such as those derived from wavelet decompositions) to perform visual tasks. Some of our work has applications to image processing problems, such as image data compression, video coding, and image denoising.

Research Figures



The squares marked A and B are the same shade of gray.

Checker Shadow Illusion

Checker Shadow IllusionThe visual system needs to determine the color of objects in the world. In this case the problem is to determine the gray shade of the checks on the floor. Just measuring the light coming from a surface (the luminance) is not enough: a cast shadow will dim a surface, so that a white surface in shadow may be reflecting less light than a black surface in full light. The visual system uses several tricks to determine where the shadows are and how to compensate for them, in order to determine the shade of gray "paint" that belongs to the surface. The first trick is based on local contrast. In shadow or not, a check that is lighter than its neighboring checks is probably lighter than average, and vice versa. In the figure, the light check in shadow is surrounded by darker checks. Thus, even though the check is physically dark, it is light when compared to its neighbors. The dark checks outside the shadow, conversely, are surrounded by lighter checks, so they look dark by comparison. A second trick is based on the fact that shadows often have soft edges, while paint boundaries (like the checks) often have sharp edges. The visual system tends to ignore gradual changes in light level, so that it can determine the color of the surfaces without being misled by shadows. In this figure, the shadow looks like a shadow, both because it is fuzzy and because the shadow casting object is visible. The "paintness" of the checks is aided by the form of the "X-junctions" formed by 4 abutting checks. This type of junction is usually a signal that all the edges should be interpreted as changes in surface color rather than in terms of shadows or lighting. As with many so-called illusions, this effect really demonstrates the success rather than the failure of the visual system. The visual system is not very good at being a physical light meter, but that is not its purpose. The important task is to break the image information down into meaningful components, and thereby perceive the nature of the objects in view.

Retrographic sensing for the measurement of surface texture and shape. Johnson, M. K., and Adelson, E. H., In IEEE Conf. on Computer Vision and Pattern Recognition (CVPR), 1070-1077 (2009)

Image statistics for surface reflectance perception. Sharan, L., Li, Y., Motoyoshi, I, Nishida S., and Adelson E.H., J Opt Soc Am A Opt Image Sci Vis. Apr;25 (4):846-65 (2008)

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Apparent Ridges for Line Drawing. Judd, T., Durand, F., and Adelson, E.H., ACM Transactions on Graphics (SIGGRAPH Proceedings), 26(3):19, (2007)

Additional Publications

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