



Physical, Computational and Perceptual Factors in Color-based Object Identification

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Abstract

Color provides one of the more salient qualities used to identify objects, particularly when objects do not differ in shape or texture, e.g. fruits differing in ripeness. Since the daylight spectrum changes with time, season, and weather, so does the spectrum of light reflected from an object. Whether people are good at color-based object identification is thus an empirical question. If they are, then it is important to identify what strategies, automatic or volitional, can account for this performance. A change in illumination spectrum causes complex changes in reflectance spectra, but because cone photo-pigments have broad absorption bands, cone responses to objects are multiplied by roughly the same constants. This multiplicative transform can be used in a number of identification strategies. When objects can be seen under two simultaneously present illuminants, identical objects have demonstrably different colors under the two lights. For such cases, the multiplicative transform can be used as a heuristic in pattern matching identification algorithms. We test such algorithms with pairs of real objects presented under two lights. Three of the objects are made from the same material and observers have to pick the odd object. This procedure provides simultaneous measures of object identification thresholds across illuminants and discrimination thresholds within illuminants. The results show that object identification is generally accurate, but with systematic inaccuracies that rule out identification algorithms incorporating the generic transform. Instead, observers infer relative colors of the illuminants from weighted spatial means, and those objects are picked as identical that are seen as most similar along the vector parallel to the illuminant color change. These experiments suggest the feasibility of geometric operations in perceptual color space that are compatible with an affine structure.

Biography

Qasim Zaidi is a Distinguished Professor of Vision Science at the State University of New York, College of Optometry. He did his Ph.D. at the University of Chicago on pre-retinal and retinal color mechanisms, and his post-doc at Bell Labs on higher-order color mechanisms. His current projects on color perception of real objects, and neural mechanisms of 3-D shape perception, are supported by grants from the National Eye Institute. He is a recipient of the SUNY Chancellor's Award for Excellence in Scholarship & Creative Activities, and a Fellow of the Optical Society of America.