Color constancy as probabilistic inference: managing the tradeoff between the illuminant prior and scene evidence

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Color is a powerful cue for object recognition. To maximize the utility of color cues, however, a vision system must try to eliminate the colorizing effects of the illuminant to access the true underlying colors of object surfaces. Starting with a foundation in Bayesian statistics, we have developed a heuristic approach to color constancy which combines an illuminant prior with evidence from the scene to estimate the most probable lighting. This estimate is a linear combination of the a priori most probable illuminant and the average chromaticity over the set of S surfaces in the scene. To determine the scene's average surface color we preprocess using anisotropic diffusion, determine the distribution of chromaticities in the scene, and then fit with a constrained mixture of gaussians using S as a parameter. The mean color of the S gaussian generators is taken as the average scene color. A weighting factor B(S) sets the relative contributions of prior vs. evidence: the more colorful the scene, the heavier the weighting of the evidence. The function B is a saturating curve whose basic form emerged from monte carlo simulations using gaussian distributions for the illuminant and reflectance priors. To benchmark our algorithm, we developed a difficult color-based recognition task using 1,500 total images of 100 objects using 3 backgrounds and 5 lighting conditions. We analyze and discuss the relative strengths and weaknesses of our algorithm in comparison to grey world, brightest-is-whitest, and several other published methods including Retinex in Matlab (Funt, et al, 2000), Comprehensive Color Image Normalization (Finlayson, et al, 1998), and Multi-Scale Retinex (Jobson, et al, 1997). We end by speculating as to the neural basis for the operations involved in illuminant color estimation and color constant visual perception.

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