A Supervised Approach to Understand Human Color Constancy

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Presentation Abstract Summary The human visual system has the ability to perceive stable object colors despite variations in the spectrum of the light reflected from objects due to variation in illumination, an ability called color constancy. Color constancy provides a model system for studying the brain's ability to combine sensory data with prior information about natural scene statistics in order to resolve ambiguity. To understand the computations that support color constancy, we developed a software pipeline that generates synthetic but none-the-less naturalistic hyperspectral color images and computes the corresponding retinal photoreceptor responses through an accurate model of the early visual system. We study these photoreceptor responses with a biologically-inspired learning method called Accuracy Maximization Analysis (AMA). AMA returns the receptive fields that select the most useful features for estimating a particular task-relevant variable. In this work, we learn the receptive fields that estimate what we call object luminance – the luminance of an object viewed under a standard illuminant (CIE-D65). Across scenes in which the illumination and the reflectance of the objects surrounding a target object vary, the AMA receptive fields, together with a Bayes-optimal decoder, estimate object luminance with a fractional root-mean-squared-error (RMSE) of ~18%, lower than errors produced by simpler methods.

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