Sensitivity to color errors in images of natural scenes

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Color errors occur in all image-reproduction processes and their visual significance may be an important factor in influencing perceived image quality. Sensitivity to these errors has been estimated using pictorial images that due to a constrained camera gamut provide chromatically limited representations of real scenes. The purpose of the present work was to estimate sensitivity to these color errors using pictures synthesized from hyperspectral images of natural scenes that have no gamut constraints.

Images of rural and urban environments were obtained by a hyperspectral imaging system (Foster, Nascimento & Amano, 2004) with a low-noise Peltier-cooled digital camera with a spatial resolution of 1344×1024 pixels (Hamamatsu, C4742-95-12ER), and a fast-tunable liquid-crystal filter (VariSpec, model VS-VIS2-10HC-35-SQ, Cambridge Research & Instrumentation, Inc., MA, USA) mounted in front of the lens. The spectral-radiance from each pixel of the images was estimated from a gray reference surface present in the scene and from calibration data obtained with a telespectroradiometer. These radiance values were then converted to points within the approximately uniform CIELAB color space. From each original image, a set of approximated images with variable chromatic errors was generated by chromatically segmenting each original CIELAB representation into cubes of side ΔE^*ab of 4 and adding to each color located inside each cube a vector with the same ΔE^*ab but with random direction from cube to cube within the image. Thus, each approximation could be characterized by a specific ΔE^*ab. The images were displayed on a calibrated 17-inch, RGB color monitor controlled by computer with raster-graphics card providing 24 bits per pixel in true-color mode. In each trial of the psychophysical experiment the observer was presented with a pair of images, corresponding to the original and one approximation, and had to indicate whether the images were the same or not.

It was found that discrimination between original an approximated images needed a ΔE^*ab of about 2.5 for rural scenes and even smaller for urban scenes. Even in complex scenes observers appear sensitive to small chromatic errors.

Foster, D.H., Nascimento, S.M., & Amano, K. (2004). Information limits on neural identification of colored surfaces in natural scenes. Vis Neurosci, 21 (3), 331-336.