

## **The contribution of color to detecting edges in natural scenes**

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In a statistical analysis of over 700 natural scenes from the McGill calibrated color image database (Olmos and Kingdom, 2004, <http://tabby.vision.mcgill.ca>) we found that luminance and chromatic edges are statistically independent. These results show that chromatic edge contrast is an independent source of information that natural or artificial vision systems can linearly combine with other cues for the proper segmentation of objects (Hansen and Gegenfurtner, 2009, *Visual Neuroscience*). Here we investigate the contribution of color and luminance information to predict human-labeled edges. Edges were detected in three planes of the DKL color space (Lum, L–M, S–(L+M)) and compared to human-labeled edges from the Berkeley segmentation data set. We used a ROC framework for a threshold-independent comparison of edge detector responses (provided by the Sobel operator) to ground truth (given by the human marked edges). The average improvement as quantified by the difference between the areas under the ROC curves for pure luminance and luminance/chromatic edges was small. The improvement was only 2.7% if both L–M and S–(L+M) edges were used in addition to the luminance edges, 2.1% for simulated dichromats lacking an L–M channel, and 2.2% for simulated dichromats lacking an S–(L+M) channel. Interestingly, the same improvement for chromatic information (2.5%) occurred if the ROC analysis was based on human-labeled edges in gray-scale images. Probably, observers use high-level knowledge to correctly mark edges even in the absence of a luminance contrast. While the average advantage of the additional chromatic channels was small, for some images a considerably higher improvement of up to 11% occurred. For few images the performance decreased. Overall, color was advantageous in 74% of the 100 images we evaluated. We interpret our results such that color information is on average beneficial for the detection of edges and can be highly useful and even crucial in special scenes.

Supported by the German Science Foundation (grant Ge-879/5).