

43.3014 VSS 2015 Approximately uniform isodiscrimination contours within a perceptual space of local image statistics Mary M. Conte, Syed M. Rizvi, Jonathan D. Victor Brain and Mind Research Institute, Weill Cornell Medical College New York, NY 10065

Motivation

- > Four-point correlations within 2x2 regions capture the informative local statistics in binarized natural images. The corresponding set of image statistics has ten parameters that range in order from 1 to 4 and embody image features such as luminance, contrast, edges, and corners.
- > Previously (Victor et al., VSS 2013) we showed that at the origin of the space (i.e., for discrimination from randomness), threshold judgments implied a simple combination rule for image statistics: they combined in a quadratic fashion, generating ellipsoidal isodiscrimination contours. Here, we extend this analysis to the periphery of the space and show that the result generalizes. We used a texture segmentation task to characterize the perceptual salience of these image statistics.



Each strip shows the textures generated by varying one coordinate across its entire range, from -1 to +1. A coordinate value of 0 corresponds to a random texture. Here, we focus on the first and second-order statistics.

Conclusions

- The sizes of isodiscrimination contours around peripheral reference points in the space were similar to their sizes at the origin.
- Around peripheral reference points, isodiscrimination contours did not have exactly the same shape as they did at the origin, and these deviations were consistent across subjects. However, the change in shape was much less than the expansion or contraction that would match the limits of the stimulus domain.
- Perceptual thresholds are determined primarily by the vector difference between image statistics. That is, the local perceptual metric is approximately Euclidean, throughout the measured space.

Analysis

Sample Weibull functions show the fraction correct for stimuli that vary in several directions from a reference point (S: MC shown). Threshold was taken to be the image statistic value to achieve a fraction correct of 0.625.



The planar plots show the perceptual thresholds in each of the coordinate planes, along with 95% confidence limits via bootstrap.

Results - Isodiscrimination contours throughout the space



The positions of the reference textures are indicated by the colored markers along the axes (*, *, *, *), or along the diagonals (*, *, *, *) in the stimulus planes above. Below, grey contours, centered at the origin, show thresholds for discriminating a structured texture from a random one. The colored contours in the periphery of the space show thresholds for discrimination from a reference texture. Each row shows data from 1 subject.



Thresholds in the periphery of the space are only slightly higher than thresholds at the origin. This is demonstrated by the isodiscrimination contours (left) and their characteristic sizes (right).

References

Rizvi, S.M., Conte, M.M., and Victor, J.D. (2014). Border salience reveals a curved global geometry of the perceptual space of local image statistics. Journal of Vision 14:654.

Tkačik, G., Prentice, J. S., Victor, J. D., and Balasubramanian, V. (2010). Local statistics in natural scenes predict the saliency of synthetic textures. PNAS USA 107:18149-18154.

Victor, J. D., and Conte, M. M. (2012). Local image statistics: maximum-entropy constructions and perceptual salience. J Opt Soc Am A Opt Image Sci Vis 29:1313-1345.

Victor J.D., Thengone D.J., Chubb C., and Conte M.M. (2013). Local image statistics: A highly conserved perceptual space encompassing statistics of low and high order. Journal of Vision 13:1233.

Support: NIH EY7977