Algorithically-defined visual textures provide a way to analyze computations performed in early vision. In this approach, image sets are synthesized to contain independent, controlled variation of several types of local features. These stimuli probe the processing of individual features and how they interact – something difficult to accomplish with natural images. Here we extend this strategy from elementary visual features to shapes.

The starting point is our texture-based analysis of contrast, edge, and corner, in which textures of black and white checks were constructed by an algorithm that controlled one, two, three, and four-point statistics in 2D neighborhoods. To extend this idea to elements of shape, we replace the uniformly black or white checks by one of two independent, controlled textures. Tokens are replaced by one of two standard checks, thresholds for 

\[
\beta, \beta_0, \beta_1, \beta_2
\]

for tokens, thresholds for checks. The tokens are approximated by elliptical contours, whose characteristics are independent of correlation sign, but for curved tokens, thresholds for \( \beta \), are lower for negative correlations. A contrasting interaction is seen for \( \beta \), Thresholds greater than 2 are not plotted.

Thresholds for ternary checks (top two rows) and curved tokens (bottom two rows). While the contours are approximately elliptical (consistent with quadratic cue combination) for ternary checks, thresholds for curved tokens, there are systematic deviations from elliptical shapes for the curved-token textures.

Conclusions

- We demonstrate algorithms for the generation of textures that are balanced for lower-level features such as length, orientation, and curvature of contours, but differ in the shapes they contain.
- Thresholds for texture segmentation based on shape, consistent across 6 observers, depend on both the order of correlation, and whether convex shapes are formed.
- Sub-threshold combination of shape cues is present, but in contrast to results for simpler cues, it is not quadratic.

References


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