Shape Categorization from Texture

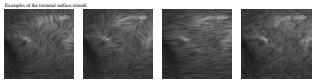
Victoria Interrante, Sunghee Kim, Haleh Hagh-Shenas, *Department of Computer Science and Engineering*, *University of Minnesota*

Motivation

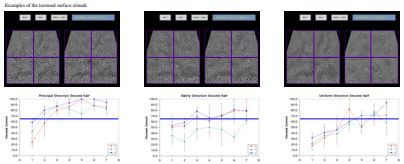
As researchers in visualization and computer graphics, we seek insight into how we might most effectively use texture to facilitate the accurate perception of the 3D shapes of arbitrary smoothly curving surfaces.

Previous Findings

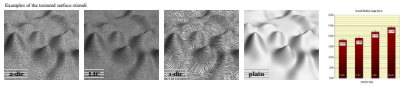
Experiment 1[1]: Judgments of local surface orientation, measured with a surface attitude probe, are more accurate with an anisotropic pattern when the texture orientation locally follows the first principal direction than when the texture follows a constant uniform direction or turns in the surface.



Experiment 2[2]: Discrimination of subtle surface shape differences, measured in a four alternative forced choice task, is possible at lower thresholds, with line and grid-like patterns, when the texture coordinate system is locally aligned with the principal directions than when it is aligned with a constant uniform direction or with a direction that turns in the surface.



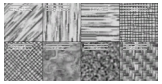
Experiment 3[3]: Judgments of local surface orientation, measured with a surface attitude probe, are marginally more accurate with a bi-directional pattern that follows both principal directions than with a uni-directional pattern that follows the first principal direction only [2dir < (1-dir, plain), p<0.01; 2dir<lic, p<0.1]



Task and Methods

4AFC Task: indicate the shape category and surface orientation;
images were 1000x1000 pixels in resolution, displayed on a 1600x1200 21"monitor, freely viewed

- 4 shape category choices: ellipsoid, cylinder, saddle, flat
- 4 surface orientation choices: convex, concave, both, neither
- 8 texture type conditions (shown at right)
- 2 viewing conditions: straight-on, oblique
- 2 projection conditions: perspective, orthographic
- 4 image rotations: 0°, 90°, 180°, 270°

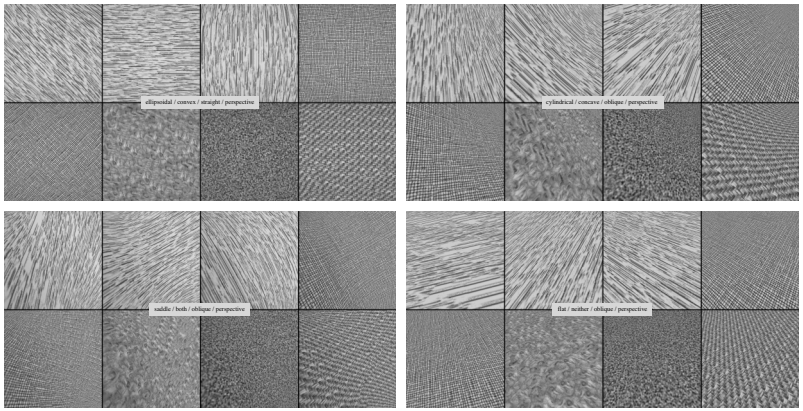


592 trials, 5 participants (plus 3 additional participants in a version with perspective images only)

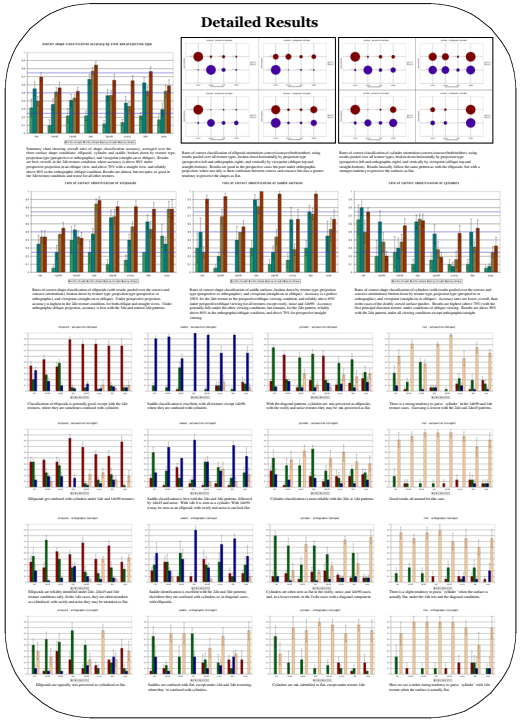
Main Findings

- Under perspective projection, shape categorization accuracy is always significantly better (or at least never significantly worse) with the '2dir' pattern than with any other texture pattern, under all surface type, surface orientation, and viewpoint conditions.
- Shape categorization accuracy is significantly better, overall, in the perspective vs. the orthographic projection condition; however categorization accuracy remains above chance in the orthographic condition for some texture types when the view is oblique.

Example Stimuli



Detailed Results



References

[1] V. Interrante and S. Kim (2016). Investigating the Effect of Texture Orientation on Shape Perception, Human Vision and Electronic Imaging VI, SPIE 4299, pp. 1-30-139.
[2] V. Interrante, S. Kim and H. Hagh-Shenas. (2017). Conveying 3D Shape with Texture Revised: Advances and Experimental Findings, Human Vision and Electronic Imaging VII, SPIE 4662, pp. 217-224.
[3] S. Kim, H. Hagh-Shenas, and V. Interrante, (2017). Showing Shape with Texture: Two Directions Seem Better than One. Human Vision and Electronic Imaging VIII, SPIE 5007, to appear.