SA73

SPECULAR FLOW AND THE PERCEPTION OF SURFACE REFLECTANCE and Shape

Stefan Roth* **Fulvio Domini†** **Michael J. Black***

BROWN UNIVERSITY

*Computer Science †Cognitive and Linguistic Sciences

I. Motivation and Introduction

Specular flow: *Dense* (or semi-dense) *image motion* of specular reflections (as opposed to just specular highlights).

Specularities have been shown to be used by humans for:
- Judging material properties (Hartung & Kersten, VSS '01)
- Static stereo perception (Blake & Bülthoff, Nature 1990)

Open question: *Is specular flow used in the perception of 3D shape?*

Figure 1: Objects with diffuse and specular reflections.

Here: We study in the absence of spatial cues whether specular flow improves discrimination capabilities between convex and concave shapes when combined with diffuse motion. Our results show that combining specular and diffuse flow indeed improves this discrimination capability.

II. Basic Stimuli

- Using a sphere as basic shape
  - Exterior of sphere as convex shape
  - Interior ("bowl") as concave shape.
- Diffuse reflection is shown using random-dot displays with uniform dot density.
- Specular reflections are displayed using random-dot or random-line displays. Specularities originate from a fixed illumination sphere around the shape.
- Camera is rotating around the object and views the scene through a round aperture.
- Stimuli are generated in real-time using hardware-accelerated OpenGL (Nvidia GeForce).

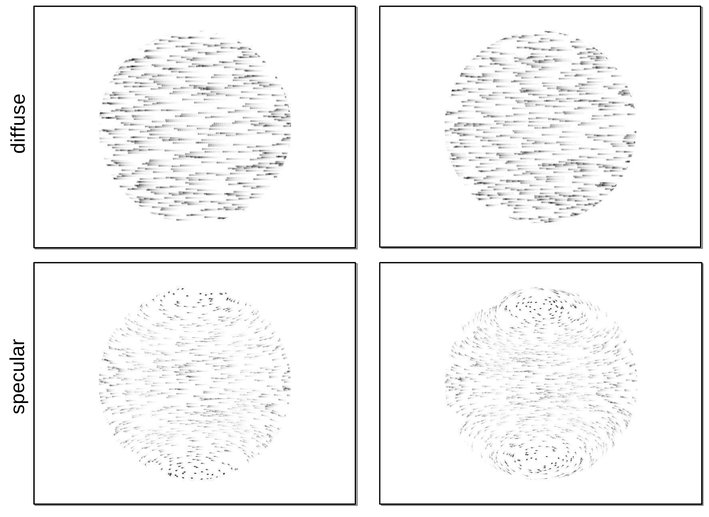


Figure 2: Motion traces showing the flow of random dots corresponding to diffuse and specular motion.

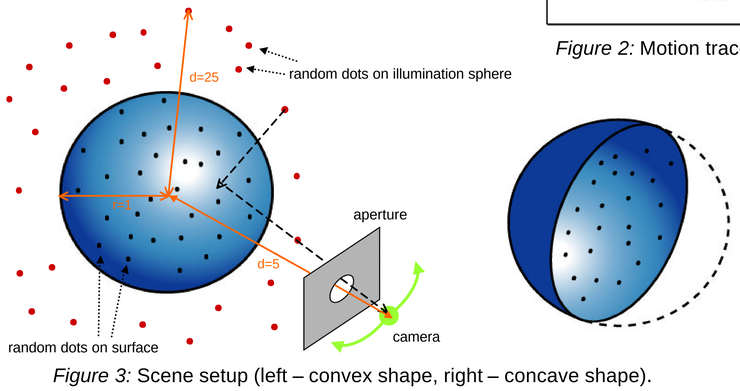


Figure 3: Scene setup (left – convex shape, right – concave shape).

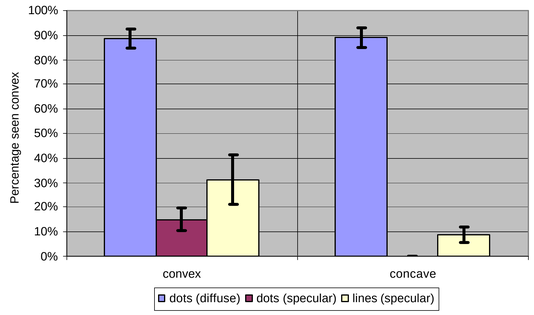
Observations

- Specular flow applied to random dots or random lines is not perceived as "shiny".
- When the illumination sources become more "natural" the object is increasingly perceived as "shiny".
- The further away the illumination sphere is, the less reflective the objects seem.

III. Experiment 1

- Single motion pattern with either diffuse (only dots) or specular reflection (dots or lines) visible.
- 10 random convex trials per stimulus and subject; 10 random concave trials. 8 subjects overall.
- Subjects view each stimulus at most 2.5 seconds before animation stops.
- Subjects make forced choice between convex and concave shape.

Results

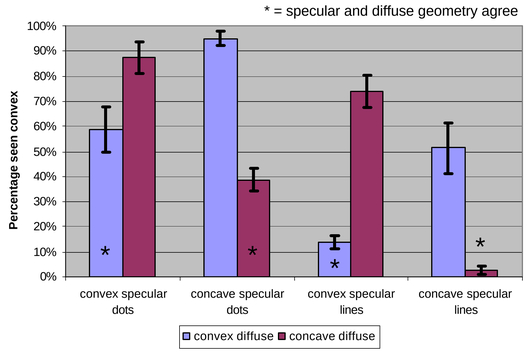


- No significant level of distinction between convex and concave shapes from just diffuse reflection.
- Specular reflections cause a strong bias towards concave.
- Specular motion patterns show significant differences between the perception of convex and concave.

IV. Experiment 2

- Diffuse and specular motion patterns are superimposed.
- Both can either be convex or concave (i.e., they can agree or disagree).
- The number of trials per stimulus, the number of subjects, and the duration of trials remains unchanged.
- Subjects still make a forced choice between convex and concave shape.

Results



- The combination of diffuse and specular flow allows significant discrimination between convex and concave shapes.
- Convex/concave combinations show a strong bias towards convex.

V. Conclusions

- Simple specular flow patterns are not perceived as "shiny", but nevertheless significantly improve the ability to distinguish convex and concave shapes when combined with diffuse motion cues.

References

1. Hartung, B., & Kersten, D. Distinguishing Shiny from Matte. Vision Sciences 2002.
2. Blake, A., & Bülthoff, H. Does the brain know the physics of specular reflection? Nature, 343, 1990.

Acknowledgements

This material is based upon work supported by the National Science Foundation under Grant No. 78441.