Can the classifier trained to separate surface texture from specular infer geometric consistency of specular highlight?

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Introduction

We can easily and rapidly recognize whether the specular highlight is consistent or inconsistent to object’s surface. However, highlight inconsistent images do not exist in the real world. Therefore, it is unlikely that the highlight inconsistency detection mechanism exists in the visual system. Instead, rather simple existing mechanisms in the visual system contribute to detect highlight inconsistency. We hypothesize two following mechanisms:

• Glossiness perception (directionality of reflectance)
• Lightness perception (albedo estimation)

Because if the highlight components are rotated or shifted to incorrect position, perceived glossiness is decreased[1-5].

We investigated whether the highlight inconsistency detection is possible by mechanisms contributing to glossiness and lightness perception.

1. Developing the classifier to separate glossiness and pigmentation
2. Verification the highlight inconsistency in the classifier

We used higher-order image statistics (PS statistics) [6] by Portilla & Simoncelli (2000) as a cue to verify our hypothesis.

Exp.1: developing the classifier

1. Generate images:
   - 1800 images × 4 categories = 7200 images

2. PS algorithm:
   - Transform to PS state:

3. PS statistics matrix:
   - 7200 × 4
   - 1200 rows

4. Canonical Discriminant Analysis (CDA):
   - k categories are projected to most separable (k-1) dimensions

5. The classifier:
   - Output space of the classifier was rotated and rescaled to fit the human data

Exp.1: result

• All images were distributed and clustered four categories
• Confirm stability of this model by 10-fold cross validation
• The higher-order image statistics termed “Linear cross position” and “Energy cross position” contributed to separate them

We could develop the classifier to separate gloss and pigment only from the image statistics.

Exp.2: verification the highlight inconsistency

Testing the classifier

1800 images

It suggested that highlight inconsistency (gloss and texture) could be detected only two simple mechanisms.

Psychophysics (rating perceived glossiness and pigmentation)

The classifier vs. human perception

Output space of the classifier was rotated and rescaled to fit the human data

Human perception: Information processing time

Conclusion

The highlight inconsistency detection is possible by mechanisms contributing glossiness and lightness perception.

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Reference

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