MATERIAL PERCEPTION IN NATURALISTIC ENVIRONMENTS
OVERVIEW

- Image cues for material properties (e.g. gloss) are confounded by:
  - **Shape**
  - **Illumination**
OVERVIEW

• Perceived gloss and shape of rendered objects is modulated by:
  • Illumination environment
  • Binocular information
  • Haptic information
SHAPE AND ILLUMINATION
Illumination direction can have dramatic effect on perceived shape

Buzz Aldrin’s footprint on the moon
Perceived shape, perceived reflectance, and visual search are consistent with same assumed illumination direction.

ILLUMINATION STRUCTURE
SOUTHAMPTON-YORK NATURAL SCENES DATASET

https://syns.soton.ac.uk

Adams et al. (2016) Sci. Reports
Luminance increases with elevation in natural light fields.
Luminance increases with elevation in natural light fields.
Compare pairs of objects from:

- *Natural illumination, or light-from-below*
- 9 gloss levels
GLOSS AND LIGHT FROM BELOW

Natural

Perceived gloss (relative JNDs)

None

Illumination Manipulation
GLOSS AND LIGHT FROM BELOW

Perceived gloss (relative JNDS)

Natural

light from below

None  Light from below
Illumination Manipulation
Luminance distribution is very skewed
Luminance distribution is very skewed.
GLOSS & LUMINANCE SKEW

Perceived gloss (relative JNDS)

- Light from below
- Uniform luminance distribution

Adams, Landy, Kucukoglu & Mantiuk (under review)
• Luminance and contrast can be large!
• Use tone mapping (e.g. sigmoidal function) to present HDR on SDR screen.
• What does this do to gloss perception?
Luminance range: 0.01 - 5000 cd/m²

High dynamic range display

DLP projector

LCD from Retina iPad
TONE MAPPING & PERCEIVED GLOSS
TONE MAPPING & PERCEIVED GLOSS

Adams, Landy, Kucukoglu & Mantiuk (under review)
BINOCULAR GLOSS CUES
GLOSSINESS
BINOCULAR GLOSS CUES
PERCEIVED GLOSS: CONVEX OBJECTS

Disparity Correct

Disparity Zero

Disparity Reversed
For **convex** surfaces, observers are sensitive to disparity sign.
For concave surfaces observers are \textit{insensitive} to disparity sign.

\textit{Kerrigan \& Adams, J Vision, 2013}
HAPTIC GLOSS CUES
VISUAL-HAPTIC MATERIALS

We use visual appearance to predict how an object will feel

» Does touch inform gloss perception?
Varied visual glossiness and haptic rubberiness.

Observers performed odd-one-out discrimination task.
VISUAL-HAPTIC POTATOES

See movie at: https://syns.soton.ac.uk/wendy_research
BI-MODAL DISCRIMINATION: TYPE 1

Haptic rubberiness (JNDs)

Visual gloss (JNDs)

Standards

1, 2 or 3?
BI-MODAL DISCRIMINATION: TYPE 1

1, 2, or 3?

Less glossy and more rubbery

Haptic rubberiness (JNDs)

Visual gloss (JNDs)

Icy, glossy

Standard

Rubbery, matte

Glossy
BI-MODAL DISCRIMINATION: **TYPE 2**
BI-MODAL DISCRIMINATION: TYPE 2

Haptic rubberiness (JNDs)

Visual gloss (JNDs)

Icy, matte

Standard

Rubbery, glossy
BI-MODAL DISCRIMINATION: EASY

Type 1 trials: discrimination was easy.

Haptic rubberiness (JNDs) > icy

Visual gloss (JNDs)

Rubbery, matte

Standard

Icy, glossy

Bimodal thresholds
(Uniform JNDs)

0.6

0.8

1.0

1.2

0 to 2
Type 2 trials: discrimination was hard.
BI-MODAL DISCRIMINATION: HARD

Consistent with prior that glossy things tend to be hard / slippery.
FEELING GLOSSY: RATINGS

• Observers explored visual-haptic objects that varied in gloss, friction and compliance and rated all three dimensions.
FEELING GLOSSY

• Why do friction and gloss interact?
• Lubricant coatings?

VISUAL-HAPTIC SHAPE AND GLOSS
VISUAL-HAPTIC SHAPE & GLOSS

Shiny and fat                         Matt and skinny

Todorovic (2014)
VARY SHAPE WITH DISPARITY
VARY SHAPE WITH DISPARITY
VARY SHAPE WITH TOUCH
VARY SHAPE WITH TOUCH
Material perception predicted by:
- Visual rendering:
  - Illumination, disparity
- Haptic rendering:
  - Touch, Friction
- Observer priors / experience