Using Blur to Affect Perceived Distance and Size

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Some slides copied from the authors.
How do we sense depth?

- **Blur**
  - Naturally in our eyes
  - More blurry = further (from focal plane)
- **Perspective**, e.g.
  - Converging parallel lines
  - Occlusion
How do we sense depth?

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Basic Lens Optics: In focus

Focal Distance $z_0$

Imaging Plane

$S_0$
Basic Lens Optics: Out of Focus

Target Distance $z_1$

Focal Distance $z_0$

Imaging Plane

$c$

$s_1$

$s_0$
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What does perspective tell us?

Diameter of Retinal Blur (°) vs. Relative Distance

focal distance (m):
- 0.10
- 1.0
- 10
- 100
Knowing relative distance and desired focal distance, how much to blur?
Image Perception

Knowing *relative distance* and *blur diameter*,

What is the focal distance?
Blur amount is inversely proportional to the relative distance

\[
\hat{c}_1 = \left| A \frac{s_0}{\hat{z}_0} \left(1 - \frac{1}{d}\right) \right| = \left| A \frac{s_0}{mz_0} \left(1 - \frac{1}{d}\right) \right|
\]

\[
= \left| \left( \frac{A}{m} \right) \left( \frac{s_0}{z_0} \right) \left(1 - \frac{1}{d}\right) \right|
\]
Example: ++blur
Examples that don't work

- Horizontal blur gradient
- Vertical blur gradient
- Linear blur / tilt-shift optics
Horizontal/Vertical Blur

Consistent Blur

Vertical Blur Gradient

Horizontal Blur Gradient

Simulated Focal Distance = 0.15m

Simulated Focal Distance = 0.06m
Normal Optics

[Diagram showing a lens and focal plane with an image of a landscape in the background.]
Tilt-Shift Optics
Simulating tilt & shift
DISCUSSION TIME!
Taking height into account
Semi-Automated

Slant-estimation Technique: Parallel Lines
Intended Focal Distance: 0.06m

Slant-estimation Technique: Manual Grid Alignment
Intended Focal Distance: 0.50m
In Black & White