

VU Rendering SS 2015

186.101

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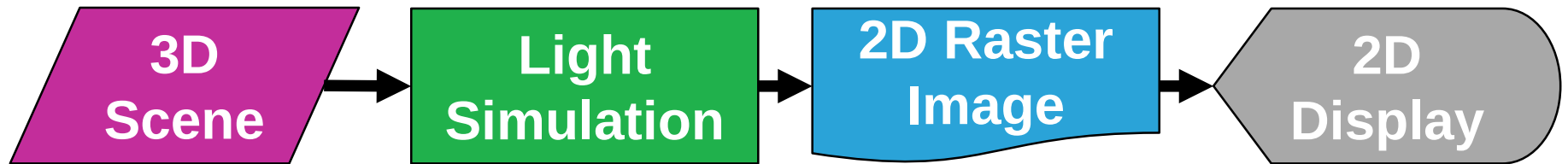


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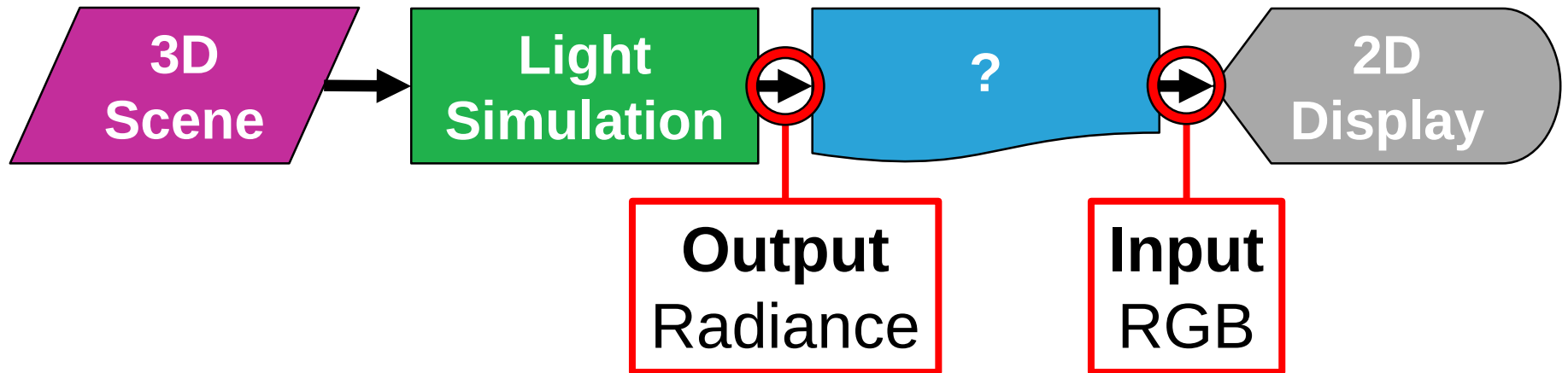
Unit 04 – Tone Mapping



Rendering pipeline



Rendering pipeline



Dynamic Range	Device/Setting
Real world	
800,000:1	Surface illuminated sun/moon
100:1	Diffuse white/black surface
80,000,000:1	Expected real world dynamic range

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Human vision	
100:1	Photoreceptors
10:1	Pupil size
100,000:1	Neural adaptation
100,000,000:1	Dynamic range of human vision



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Real world	
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100,000,000:1	Dynamic range of human vision
Technology	
1,000:1	Display
256:1	8 bit image file



- Output of our light simulation:
real world dynamic range or
High dynamic range (HDR)
- Input of conventional display devices:
Low dynamic range (LDR)
- Need to apply range compression. Referred to as
 - **Tone mapping**
 - **Tone reproduction**



1. **Range compression**

Convert HDR luminance to LDR luminance
(Content of this lecture)

2. **Color space conversion**

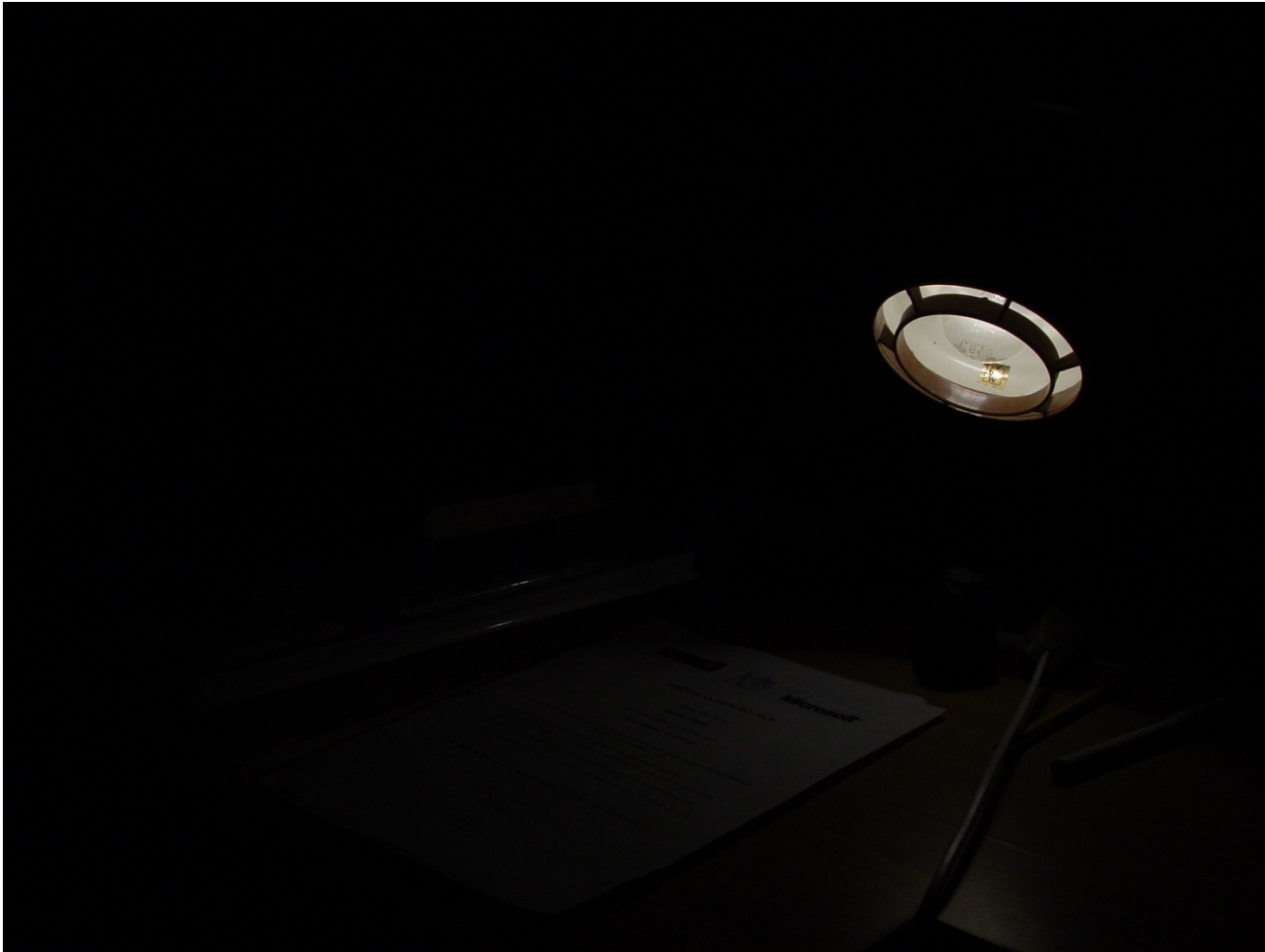
Convert LDR luminance to desired color space
(RGB, XYZ, CMYK, ...)
(Covered in the color lecture 186.826)



Bright light source with no ambient light



Short exposure



Long exposure



Division by maximum



Clamp



Exponential mapping



Reinhard tone mapper





Read http://www.cs.bris.ac.uk/~reinhard/tm_comp/





Read http://www.cs.bris.ac.uk/~reinhard/tm_comp/



■ Global

Mapping function is uniform on the whole image.

■ Local

Mapping function depends on the values of the pixels in the neighborhood of the currently mapped pixel.



■ Global

Mapping function is uniform on the whole image.

+ Fast

- Loss of detail

■ Local

Mapping function depends on the values of the pixels in the neighborhood of the currently mapped pixel.

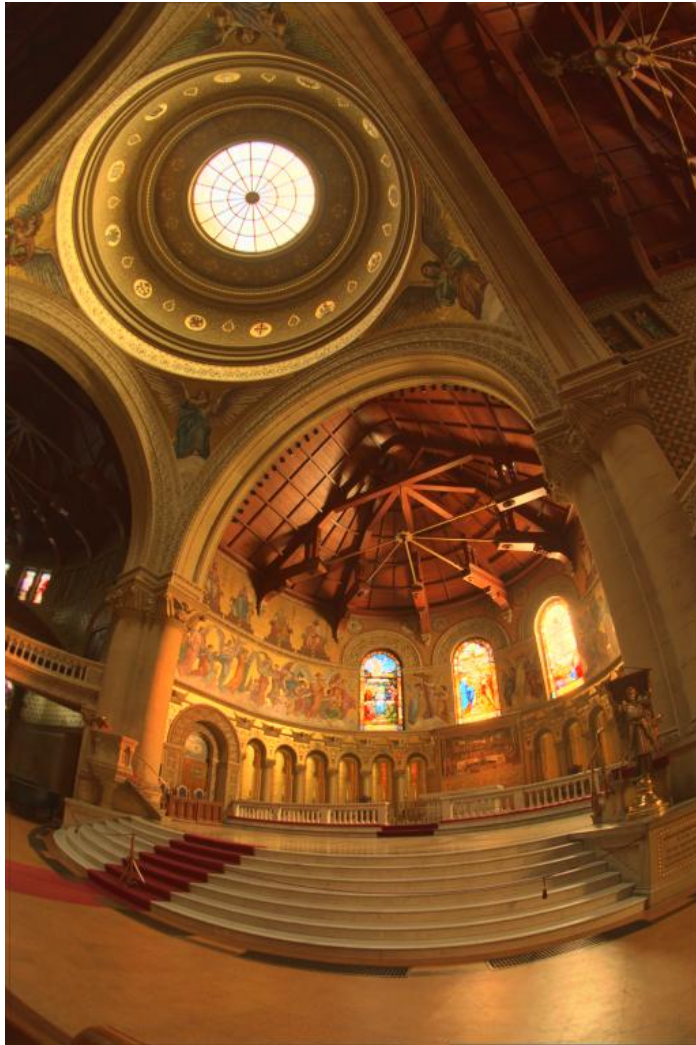
- Slow

+ Local contrast enhancement

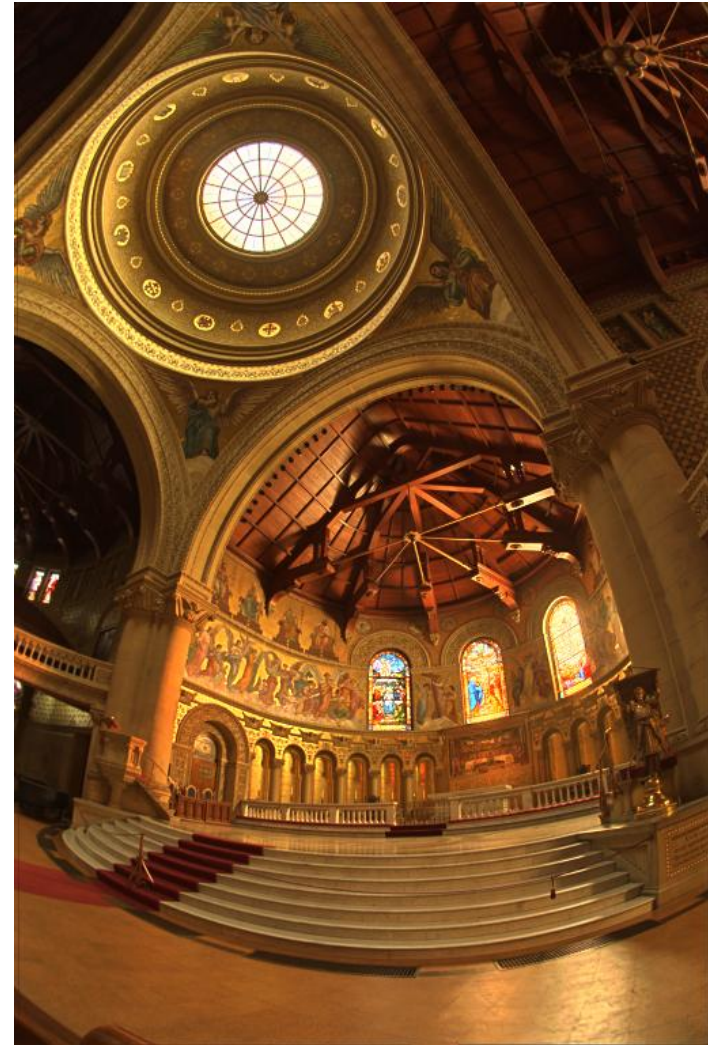


- Developed by Reinhard et al.
Reinhard et al., *Photographic tone reproduction for digital images*, Siggraph 2002
- Widely used
- Global and local variant





Global



Local

(from http://cybertron.cg.tu-berlin.de/pdci08/tonemapping/tone_mapping.html)



Processing steps (global version)

- Compute log average (luminance space)

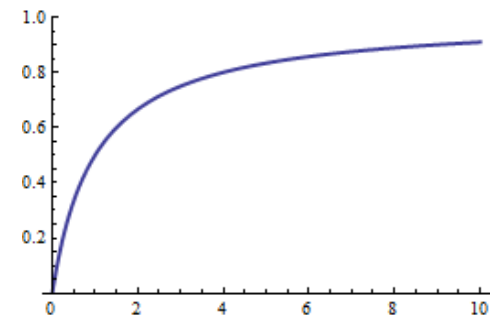
$$L_{\text{avg}} = \exp \left(\frac{1}{N} \sum_{x,y} \log(L_{\text{input}}(x, y)) \right) = \sqrt[N]{\prod_{x,y} L_{\text{input}}(x, y)}$$

- Map average value to *middle-gray* given by a

$$L_{\text{scaled}}(x, y) = \frac{a}{L_{\text{avg}}} L_{\text{input}}(x, y)$$

- Compress high luminances

$$L_{\text{output}}(x, y) = \frac{L_{\text{scaled}}(x, y)}{1 + L_{\text{scaled}}(x, y)}$$



Processing steps (local version)

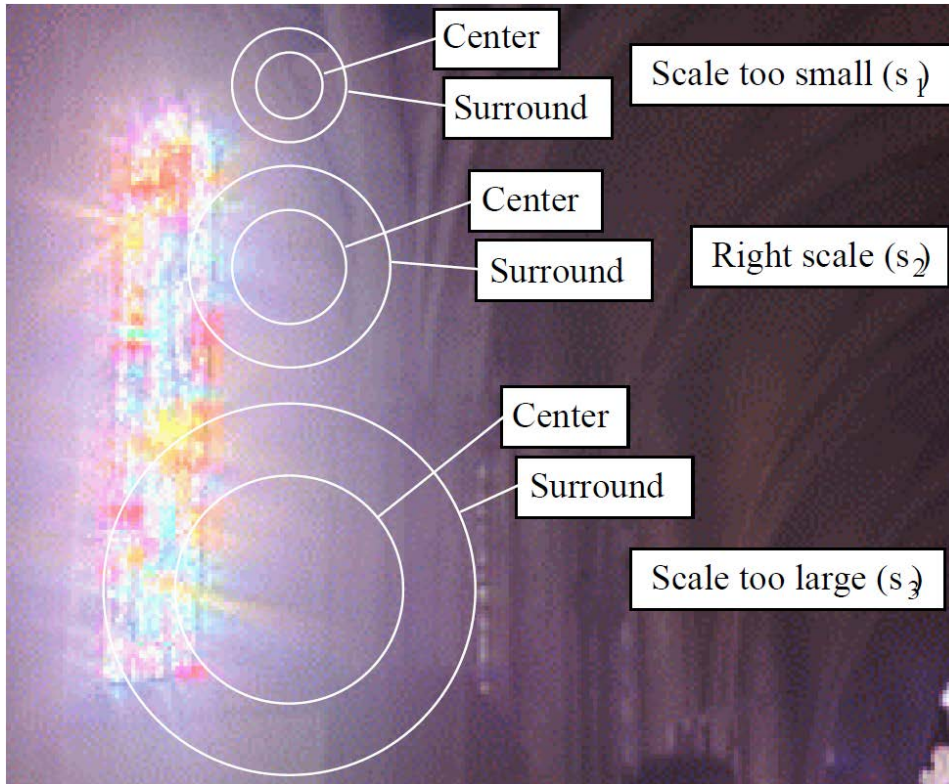
- Compute log average
- Map average value to *middle-gray*
- Compress luminances by spatially varying function

$$L_{\text{output}}(x, y) = \frac{L_{\text{scaled}}(x, y)}{1 + V(x, y, s(x, y))}$$

- Local average $V(x, y, s)$ with scale s (think Gaussian smoothing).
- Local scale $s(x, y)$ where $L_{\text{scaled}}(x, y)$ does not change.



Scale estimation at circle center points



(from Reinhard et al. 2002)

- **Center** area should be smooth
- **Surround** area should not be smooth





Global

(from http://cybertron.cg.tu-berlin.de/pdci08/tonemapping/tone_mapping.html)



Local



Wide variety using

- bilateral filters

F. Durand and J. Dorsey, *Fast bilateral filtering for the display of HDR images*, Siggraph 2002

- gradient processing

Fattal et al., *Gradient domain HDR compression*, Siggraph 2002

- etc... (wikipedia.de lists over 20)



Textbooks

- Reinhard et al., *High Dynamic Range Imaging*, 2. ed., 2010

Papers

- Reinhard et al., *Photographic tone reproduction for digital images*, Siggraph 2002
- F. Durand and J. Dorsey, *Fast bilateral filtering for the display of HDR images*, Siggraph 2002
- Fattal et al., *Gradient domain HDR compression*, Siggraph 2002



Questions?

Original Render, saved to OpenEXR



Tone mapped with Local Adaptation



(from <http://www.artstorm.net/journal/2009/07/color-management-linear-workflow/>)

