CS 563 Advanced Topics in Computer Graphics
Film and Image Pipeline (Ch. 8)
Physically Based Rendering

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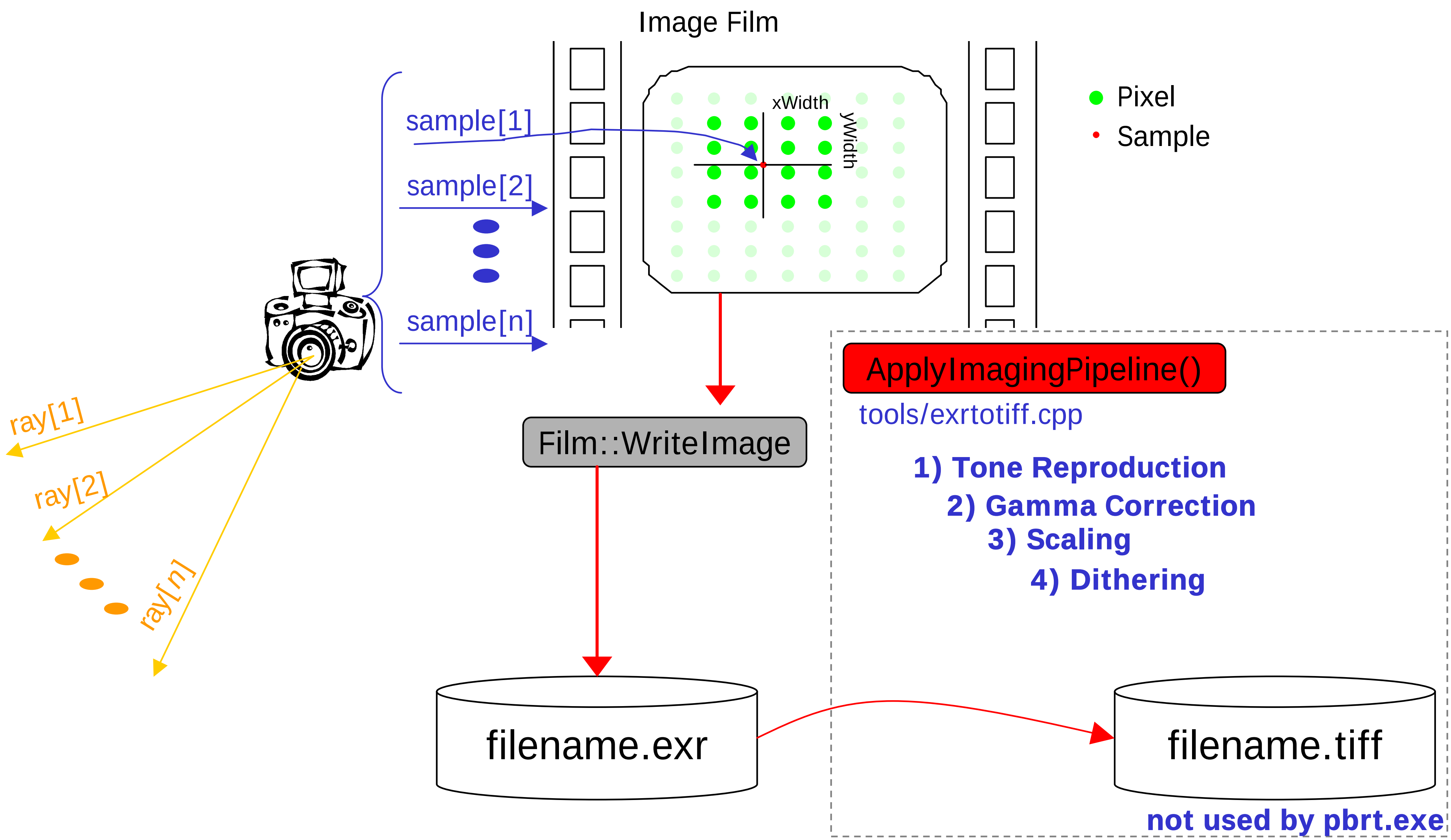
Film and Image Pipeline

- **Basic Challenge:**

  PBRT's output (EXR) avoids some loss by leveraging a format that utilizes floating-point color values. PBRT.EXE however does not "compensate" for reality of display device constraints. It does provide a means for transformations that can be applied during image quantization in order to retain as closely as possible the ideal image for "realistic" display. Ultimately a discrete pixel values have to be assigned.

- **Key Pipeline Components:**
  - Film Interface
  - Image Film
  - Image Output
  - Image Pipeline

Film and Image Pipeline



Film and Image Pipeline

- **Film Interface:**

Very basic functions with limited functionality

```
Film(int xres, int yres)
Film::AddSample()
   updates image during rendering
Film::WriteImage()
   called by Scene::Render() as rendering loop exits
Film::GetSampleExtent()
```

Film and Image Pipeline

- **Image Film:**

Only “built-in” Film Implementation

  - filter function
  - crop window
  - alpha values
  - Image Output

Film and Image Pipeline

- **Image Pipeline:**
  - Tone Reproduction

    remap wide range of pixel radiance values to range the display is capable of
  - Gamma Correction

    account for non-linear relationships between color values sent to the the display and their brightness on the display
  - Scaling

    cover range of input values expected by the display
  - Dithering

    small amount of random noise to pixel values to help break up transitions

Film and Image Pipeline

- Luminance & Photometry
  - HVS may observe varying degrees of brightness given the same SPD for various frequencies (i.e. Green vs. Blue)
  - luminance is closely related to radiance.
  - Given radiance, luminance can be computed with a simple conversion formula

Luminance (cd/m2, or nits)	
600,000	Sun at Horizon
120,000	60-watt light bulb
8000	Clear sky
100-1000	Typical office
1-100	Typical computer display
1-10	street lighting
0.25	Cloudy moonlight

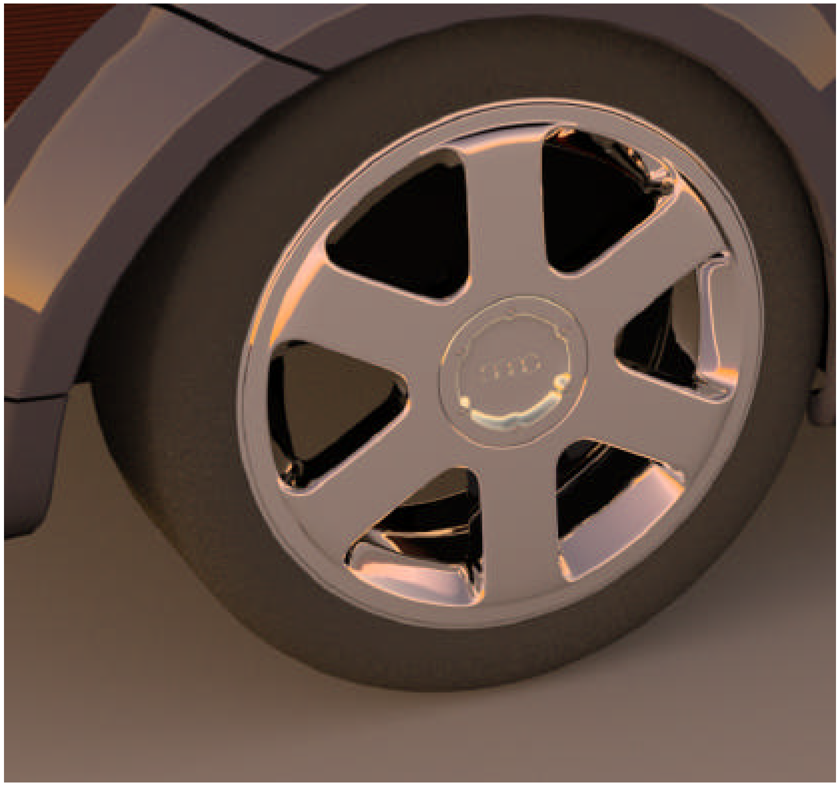
Film and Image Pipeline

- Bloom
  - Compensates for inability of Display Devices to Display Accurate luminance (see prev. slide)
  - effect causes a blurred glow in the area around the bright object
  - “Tricks” HVS into perceiving that an image on a display is brighter than it really is
  - Although actual anatomical HVS reasons are not fully understood “simulating” the effect creates a perceived better “realism”

Film and Image Pipeline

p. 383 Fig. 8.3 (a)

Bloom effect applied



p. 383 Fig. 8.3 (b)

W/O Bloom Effect

Film and Image Pipeline

- Bloom Algorithm

  2 params (bloomRadius & bloomWeight)

  Possibly Apply (!bloomRadius<=0)

  compute pixels effected

  initialize bloom filter table

  - avoids feedback

  - precompute for future reference

  compute new pixel values

  mix into original image

  bloomRadius of .1 or .2 are good practical starting values

Film and Image Pipeline

- Radiance Values

(Understanding the Challenge)

  - PBRT accurately encodes The basilica scenes with multiple orders of magnitude of radiance values
  - HOWEVER, the standard approach of choosing a fixed radiance value to “map” to the brightest displayable value performs poorly

Q: What’s wrong?

A: HVS can see detail through the entire scene.

Analysis:

In All 3 images the light from the windows is blown out

In the Top and Middle Images some areas are too dark to make out much details

In the bottom Image large regions map to the max value (no details remain)

More Sophisticated tone mapping algorithms are needed.

Max Radiant Values

x

10x

100x

p. 383 Fig. 8.4 St. Peter’s Basilica in Rome

Film and Image Pipeline

p. 392 Fig. 8.5 St. Peter's Basilica in Rome

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p. 393 Fig. 8.6 St. Peter's Basilica in Rome

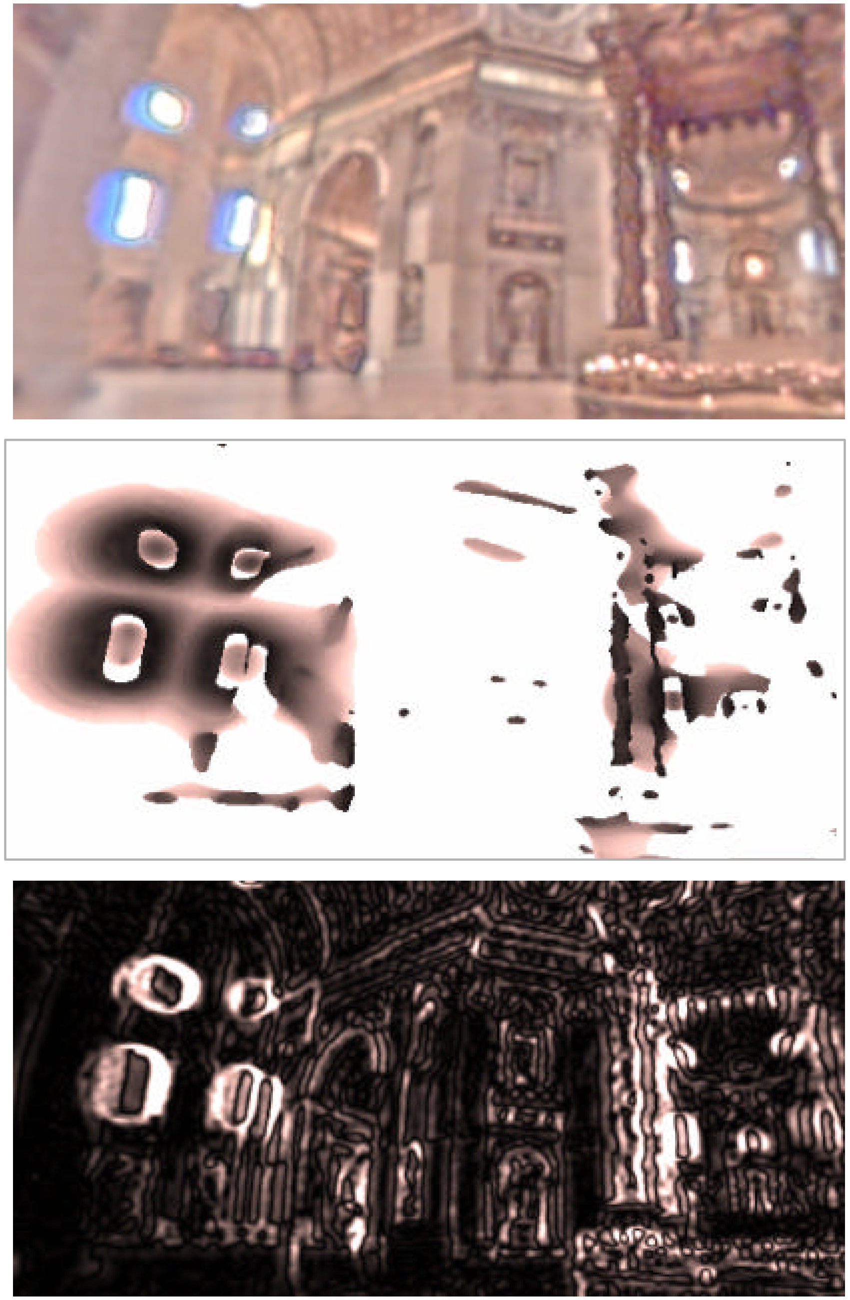
High-Contrast tone reproduction

computes a spatially varying adaptation luminance while paying attention to boundaries between areas with substantially different luminances.

Top: An Excellent Result

Middle: A gray scale visualization

Bottom: local contrast computed at each pixel with a blur radius of 1.5 and 3 pixels



p. 395 Fig. 8.7 St. Peter's Basilica in Rome

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p. 401 Fig. 8.8 St. Peter’s Basilica in Rome

Film and Image Pipeline

- References
  - All Images Obtained from “Physically Based Rendering” CD-ROM

  Gregg Humphreys & Matt Pharr