New Features in Radiance 2022

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Minor Fixes/Enhancements (1)

- New `pabopto2bsdf` "-s up" for 180° rotational symmetry and -g option for grazing sample culling
  - Also, finally wrote man pages for this and other BSDF interpolation tools
- Fixed minor inconsistency in BSDF rendering in cases where reciprocity is not strictly obeyed
- Made corrections to Klems half- and quarter-bases
- Added exposure preservation to `pcompos` where possible, and better handling of `pcomb` -o option
  - These changes allow more reliable interoperation with `evalglare`
- Added "-DSHARP_RGB" compile-time option for enhanced color accuracy
- Fixed floating point errors in ambient super-sampling
Minor Fixes/Enhancements (2)

• Added -O option to pvalue and pextrem to report radiometric values even when picture is XYZE format
• Implemented header alignment to enable memory-mapped loading of binary files, which is now used by rmtxop under Unix with “double” format
• Removed ambient-value sorting, which was overly complex and no longer beneficial in most cases
• Added dctimestep -x and -y options to control picture dimensions when result is plain vector
• Created rcalc -P option to pass unchanged input that does not satisfy “cond” (-p option still elides)
Major Changes/Additions (1)

- Incorporated `ies2rad` upgrades from Randolph Fritz
- Improved behavior of -aw rendering option, so it does not tend to bias result as it did
- Added `getinfo -r` option, similar to -a but replaces or deletes specified header variable(s)
- Created `checkBSDF` tool for testing BSDF XML files for total transmission, reflection, and reciprocity
- Created `iso2klems` script to compute Klems BSDF files that obey reciprocity
Major Changes/Additions (2)

- Created `rcrop` utility for cropping matrices and pictures more efficiently, correcting view information if present.
- Added automatic overture calculation to `rtpict` with `-n > 1` if ambient cache is on and shared file is used.
  - Improves multi-processing speed-up in many cases.
- Added `cnt -s` option to shuffle output order, used in updated `rtpict`.
- Added support for depth-of-field blur in `vwrays`, also used by `rtpict`.
ies2rad Improvements from Randolph Fritz

• Generates correct Radiance geometry for spheres in 1995, 2002, and 2019 IES files

• Generates correct Radiance geometry for vertical cylinders that are taller than they are wide

• Ignores the file source ("File Generation Type") field in the 2019 version of the file, which would otherwise be incorrectly used as an output multiplier
ies2rad Improvements (2)

• Shape information is included in the .rad file comments

• 1995, 2002, and 2019-version luminous opening geometry is accounted for

• The 2002 and 2019 IES file versions are recognized and processed appropriately

• Attempted to do something intelligent with less common "luminous opening" shapes in the 1995, 2002, and 2019 versions of the standard, but not implemented any support for new geometry; approximations are substituted and warning messages are issued
  o Code is untested, due to lack of IES files using these shapes
Improved -aw Option

- Improved behavior of little-used -aw rendering option
  - Estimates -av value from average of computed cache values

- New code avoids sea-level rise from adding its own estimate back into the ambient calculation

- We now derate the final average by the factor corresponding to mean surface absorption
  - Effectively removes the average from the final bounce estimate
Improved -aw Option (2)

Railings excluded from interreflection calculation
New `getinfo -r` Option (1)

• Existing `-a` option behavior:

```plaintext
#?RADIANCE
oconv basic.mat diorama_walls.rad
rpict -av .5 .5 .5 @render.opt
EXPOSURE=5.1
FORMAT=32-bit_rle_rgbe
```

getinfo -a "EXPOSURE=0.17" "VIEW=-vp 10 15 9 -vd 0 -1 0" "rpict"

```plaintext
#?RADIANCE
oconv basic.mat diorama_walls.rad
rpict -av .5 .5 .5 @render.opt
EXPOSURE=5.1
EXPOSURE=0.17 <= added
VIEW=-vp 10 15 9 -vd 0 -1 0 <= added
rpict <= added
FORMAT=32-bit_rle_rgbe
```
New getinfo -r Option (2)

- New -r option behavior:

```r
/?RADIANCE
oconv basic.mat diorama_walls.rad
rpict -av .5 .5 .5 @render.opt
EXPOSURE=5.1
FORMAT=32-bit_rle_rgbe
```

getinfo -r “EXPOSURE=0.17” “VIEW= -vp 10 15 9 -vd 0 -1 0” “rpict”

```r
/?RADIANCE
oconv basic.mat diorama_walls.rad
EXPOSURE=0.17
VIEW= -vp 10 15 9 -vd 0 -1 0
FORMAT=32-bit_rle_rgbe
```

Input

Output

- rpict line deleted
- replaced
- added
New checkBSDF Tool (1)

• Example output:

  File: 'aerc6220new.xml'
  Manufacturer: ''
  BSDF Name: ''
  Dimensions (W x H x Thickness): 0 x 0 x 0 cm
  Type: Klems_Full
  Color: 0
  Has Geometry: 0

  Component  Lambertian  XYZ (%)  Max. Dir  Min. Angle
  Interior Refl  34.0  34.0  34.0  19.8%  8.56 deg
  Exterior Refl  34.0  34.0  34.0  19.8%  8.56 deg
  Int->Ext Trans  0.0  0.0  0.0  10.0%  8.56 deg
  Ext->Int Trans  0.0  0.0  0.0  9.9%  8.56 deg

  Component  Reciprocity Error (min avg max %)
  Interior Refl  0.0  0.0  0.1
  Exterior Refl  0.0  0.0  0.1
  Transmission  0.0  1.3  99.1
New checkBSDF Tool (2)

- Example output:

File: 'BIMSOL036_g7_t97-a.xml'
Manufacturer: 'Manufacturer'
BSDF Name: 'Mecho_shade_fabric_6216-63__(LBL)'
Dimensions (W x H x Thickness): 0 x 0 x 0 cm
Type: Isotropic_Tensor_Tree
Color: 0
Has Geometry: 0

Component Lambertian XYZ (%) Max. Dir Min. Angle
Interior Refl 0.0 0.0 0.0 29.3% 0.90 deg
Exterior Refl 0.0 0.0 0.0 52.8% 0.90 deg
Int->Ext Trans 0.0 0.0 0.0 1.7% 0.90 deg
Ext->Int Trans 0.0 0.0 0.0 1.8% 0.90 deg

Component Reciprocity Error (min avg max %)
Interior Refl 0.0 47.1 100.0
Exterior Refl 0.0 42.0 100.0
Transmission 0.0 54.9 99.6
New iso2klems Script

• Takes tabulated isotropic diffuse and specular transmittance & reflectance values as a function of incident polar angle (0-180°)
• Produces a full-Klems XML file that matches input and generally obeys reciprocity, which is not true of previous IGDB data calculated by older methods
• Partial input (header row is optional):

<table>
<thead>
<tr>
<th>theta (°)</th>
<th>Tspec</th>
<th>Tdiff</th>
<th>Rspec</th>
<th>Rdiff</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>.07</td>
<td>.1</td>
<td>0</td>
<td>.15</td>
</tr>
<tr>
<td>25</td>
<td>.06</td>
<td>.11</td>
<td>0</td>
<td>.14</td>
</tr>
<tr>
<td>55</td>
<td>.05</td>
<td>.13</td>
<td>0</td>
<td>.12</td>
</tr>
<tr>
<td>80</td>
<td>.005</td>
<td>.08</td>
<td>0</td>
<td>.18</td>
</tr>
</tbody>
</table>

(should continue to theta=180°)
New rcrop Utility (1)

- General, efficient, robust tool for cropping matrices, Radiance pictures, normal and depth maps
- Preserves exposure and crops VIEW parameters in header where appropriate
- Uses fseek() on binary files if possible, and works on unparsed words in ASCII files (similar to rcollate)
- Usage:
  \[ \text{rcrop} \text{ row0 col0 nrows ncols [input [output]]} \]

- Note that rows are numbered from the top
  - If nrows or ncols = 0, then remaining rows/columns are included
New rcrop Utility (2)

rcrop header:

```bash
#?RADIANCE

doconv environ.rad pedestal.rad wavy_vase.rad
SOFTWARE= RADIANCE 4.2a lastmod Tue Aug  6 22:10:14 PDT 2013
CAPDATE= 2013:08:15 22:30:03
GMT= 2013:08:16 05:30:03
pfilt -x /3 -y /3 -m .2 -1 -e -1
EXPOSURE=5.000000e-01
rcrop 1030 315 479 790
VIEW= -vp -75.4 -20 60.2 -vh 11.81 -vv 7.17 -vs -.17 -vl -.51
FORMAT=32-bit_rle_rgbe
```
rtpict Ambient Cache Performance (1)

- Previously, multi-processing in rtpict with an ambient cache resulted in less than linear speed-ups
  - Problem: multiple rtrace processes working on the same scene regions
- Latest rtpict shuffles ray samples in a way that encourages different regions to be sampled by each sub-process
  - Uses new cnt -s option and calls Unix sort utility to reassemble the pixels in the correct order afterwards
- If output other than a picture is requested, rtpict performs an overture calculation instead to fill the irradiance cache prior to its normal run
  - Again, using cnt -s to shuffle the samples, but discarding rtrace output
**Ambient Cache Performance (2)**

<table>
<thead>
<tr>
<th>Method</th>
<th>#processes</th>
<th>CPU time</th>
<th>Wall time</th>
<th>Speed-up</th>
<th>#ambient</th>
</tr>
</thead>
<tbody>
<tr>
<td>rpict</td>
<td>1</td>
<td>1180</td>
<td>1180</td>
<td>1</td>
<td>13.5 K</td>
</tr>
<tr>
<td>rpiece*</td>
<td>4</td>
<td>1380</td>
<td>345</td>
<td>3.4</td>
<td>12.4 K</td>
</tr>
<tr>
<td>old rtpict</td>
<td>4</td>
<td>1786</td>
<td>446</td>
<td>2.6</td>
<td>25.1 K</td>
</tr>
<tr>
<td>new rtpict*</td>
<td>4</td>
<td>1307</td>
<td>327</td>
<td>3.6</td>
<td>14.2 K</td>
</tr>
<tr>
<td>new rtpict</td>
<td>4</td>
<td>1218</td>
<td>305</td>
<td>3.9</td>
<td>10.4 K</td>
</tr>
</tbody>
</table>

*Includes ambient cache overture calculation*
New **cnt -s** option

- Originally one of the simplest tools in Radiance, **cnt** generates looped variable indices, e.g:

<table>
<thead>
<tr>
<th>cnt</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>cnt -s</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- New -s option shuffles the output, similar to passing through `sort -R`, but hundreds of times faster
- Employs memory-efficient allocation bitmap
  - Shuffles index lists of 2 billion entries in 250 MB of RAM
Depth-of-field Support in vwrays and rtpict (1)

- Implemented new jitteraperture() library call

- New function called by vwrays as well as rtpict
  - previously, rtpict implemented this in src/rt/rpict.c

- Standardizes depth-of-field sampling for bokeh
  - Samples random position on disk corresponding to lens aperture

- Enables rtpict to support -pd option, since it calls vwrays for ray generation
Depth-of-field Support in vwrays and rtpict (2)

-pd 2 (focus on king)
Questions?