HDR Application in Quality Assurance

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About us, HELLA

www.hella.info

- HQ in Abfaltersbach, Tirol, Austria
- 60 yrs anniversary 2019
- family owned
- Full line distributor: everything for daylight mgmt, its integration into facades & controls
  - Roller shutters
  - Venetian Blinds (int, ext)
  - Roller Blinds (int, ext)
  - Box systems, Soffit systems, window attached boxes (top mounted)
  - awnings.
  - Outdoor living (Pergola)
  - ONYX
Venetian Blinds in CCF

Bishopsgate, London

100 Mount Street, Sydney

josef-gartner.permasteelisagroup.com

What’s a roller shutter?
Roller Shutters
Why QA HDR?
Night Shift
22:00 – 06:00

Sleeping anytime between
06:00 – 22:00

BUT:
A roller shutter is no obscuration device, by definition.
Roller Shutter: Hinge System

Full contact in closed position

Stretched whenever moving

Aluminum slats
Process Quality – Manufacturing Tolerances

Starting point: Aluminum Coil incl. tolerances

• Lengthwise curvature (x & y)
• Lengthwise Torsion (z)
• Tolerances in Section x,y-pane
  • Roll dies
  • PUR hardening pressures
• Position of punches
• Burrs
  • Slat ends
  • punches
• Tolerances in Band surface
The issue is

a. Transmission through guiderails

b. Transmission through hinges

c. Transmission through slats

This work focuses on (b) Transmission through hinges.
Objective:
Cancel out subjective evaluation
gphoto2 → Response curve → Calibration & Vignetting → Postprocess
Testbox
Testbox

LED PWM dimmable, 6500K
E = 16-23klx @ 100% (-> reasonable daylight scene)
L= 4-5kcd/m² @ 100%
Diffusor is not completely lambertian!

Dedicated, completely dark room is needed!

Fixed Position of Camera (in future)

f/4.5, ISO 800 or 1600; A-Mode (Aperture fixed, Time adjusted); AF mechanically deactivated
Gphoto2

Nikon D40 Version 1.10 – stick to this ancient device
Canon EOS 800D
-> well known and described all over the web
Response Curve
PWM Dimming on LED Sources!

Finetuning due to the 20 < RGB value < 200 constraint … no dimming allowed!

99% 50%
Radiance Workshop 2019

Response Curve ISO 200, 400, 800, 1600, degree 4

f/4.5

Calibration Factor ~ 1/0.8 – 1/0.8!
Vignetting & Calibration Factor
Vignetting testing
Different apertures

<table>
<thead>
<tr>
<th>Luminance reading [cd/m²]</th>
<th>5200</th>
<th>5000</th>
<th>5377</th>
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<tbody>
<tr>
<td>4600</td>
<td>4220</td>
<td>4820</td>
<td></td>
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<td>4800</td>
<td>4078</td>
<td>4950</td>
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<td>4195</td>
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</tbody>
</table>

Aug. 22nd. 2019
Radiance Workshop 2019
Vignetting + calibration

Depending on Aperture setting!

- f/4.5
- f/8

@18mm

Assumption:
Radially symmetric

![Graph showing Vignetting Polynom with polynomial equations](image)
Vignetting corrected

Still an max. error of approx. 3.5%
Distortion

Up to now neglected but open issue

-> All luminance data is obviously affected by it!
Quality Indicators
Quality

Number of individual sources

Style of cluster
  - linearity

Luminance per source
  - Viewpoint?

Luminance per cluster

Contributing illuminance

?
1. Matlab readhdr (missing in octave)
2. Pvalue -> *.dat -> gnuplot (terrible files)
3. Findglare (not on hdr?)
4. evalglare

## Tools considered or tested

<table>
<thead>
<tr>
<th>Quality</th>
<th>Number of individual Sources</th>
<th>Style of cluster</th>
<th>Luminance per source</th>
<th>Luminance per cluster</th>
<th>Contributing Illuminance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>• linearity</td>
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</table>

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## Qualitative Criteria & Tools

<table>
<thead>
<tr>
<th></th>
<th>Matlab</th>
<th>pvalue-&gt;gnu</th>
<th>Evalglare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of sources</td>
<td>small</td>
<td>High</td>
<td>per pixel only</td>
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<tr>
<td>Style of Cluster</td>
<td>linear</td>
<td>Random</td>
<td>unknown</td>
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<tr>
<td>Luminance of source</td>
<td>small</td>
<td>High</td>
<td>ok</td>
</tr>
<tr>
<td>Luminance of Cluster</td>
<td>small</td>
<td>High</td>
<td>missing</td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Matlab readhdr

Contribution from our intern Marco Bachmann
Pvalue - gnuplot
Using pvalue + gnuplot

pvalue -o -b -h -H hdr_in.hdr > data_out.txt

• Lars mailing list entry 2006
Evalglare

evalglare -f -A mask.hdr -d -b $b -r $r -i $evlxi -c checkfile.hdr in.hdr > detail_output.dat
evalglare

```
evalglare -f -A mask.hdr -d -b $b -r $r -i $evlx -c checkfile.hdr in.hdr > detail_output.dat
```

- **f** ... force to work on no-fisheye images and wrong headers
- **A** ... mask file (statistics on this area but no changes in source detection -> crop image for masking of source detection algorithm)
- **d** ... enables output of source description -> piped into a *.dat file
- **b** ... multiplicator of source above mean luminance
- **r** ... measured vertical illuminance – in our application below measurement threshold 0.1
- **c** ... enables the generation of the *.hdr showing the sources color shaded
Parameter setting b & r

Stretched shutter = visible punch holes

Two types of slats (52 mm & 37 mm)
K52 slat
-b 2 -r 0.2
-b 2 -r 0.1
-b 2 -r 0.05
-b 2 -r 0.02
-b 2 -r 0.01
K52 closed with artefacts
Peaks approx. 55pixel in x &
9 pixel in y-direction

@3x2Megapixel Resolution

Indication:
55pixel/peak / 3000pixel/66° = ~0.021rad/peak in x-direction
9pixel/peak / 2000pixel/47° = ~0.004rad/peak in y-direction
A37 slat
-b 2 -r 0.1
-b 2 –r 0.05
ISO setting
ISO 800 or 1600

-b 2 –r 0.02
Session K52 7

ISO 800

ISO 1600
Test series
A37

series of 8
A37 – mask result

Output of evalglare mask algorithm
mask = full image, which was cropped beforehand

4 Series
Identical shutter
Moving between measurements

Too early too show real statistic
A37 – manipulated

Output of evalglare mask algorithm
mask = full image, which was cropped beforehand

std_lum changes most
A37 1
- b 6 – r 0.01
A37 2 - b 6 – r 0.01
A37 3
- b 6 – r 0.01
A37 5
Artefact
K52
-b 4 – r 0.02
Result
Assessment Result

A) Quantified: Evolving Statistic of evalglare maskdata
   • no_pixels
   • Omega
   • av_lum
   • median_lum
   • std_lum
   • perc_75
   • perc_95
   • lum_min
   • lum_max

B) Qualitative: Evolving x,y,circle plots
evolving statistics

All* within whiskers**?

NO : bad
YES: good

*) ... to be defined;  
**) ... or outliner using IQR
This result is detectible in:
- Falsecolour image
- std_lum
If added – new outliner
B) x,y,circle
Acknowledgement
References

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