WebHDR

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WebHDR

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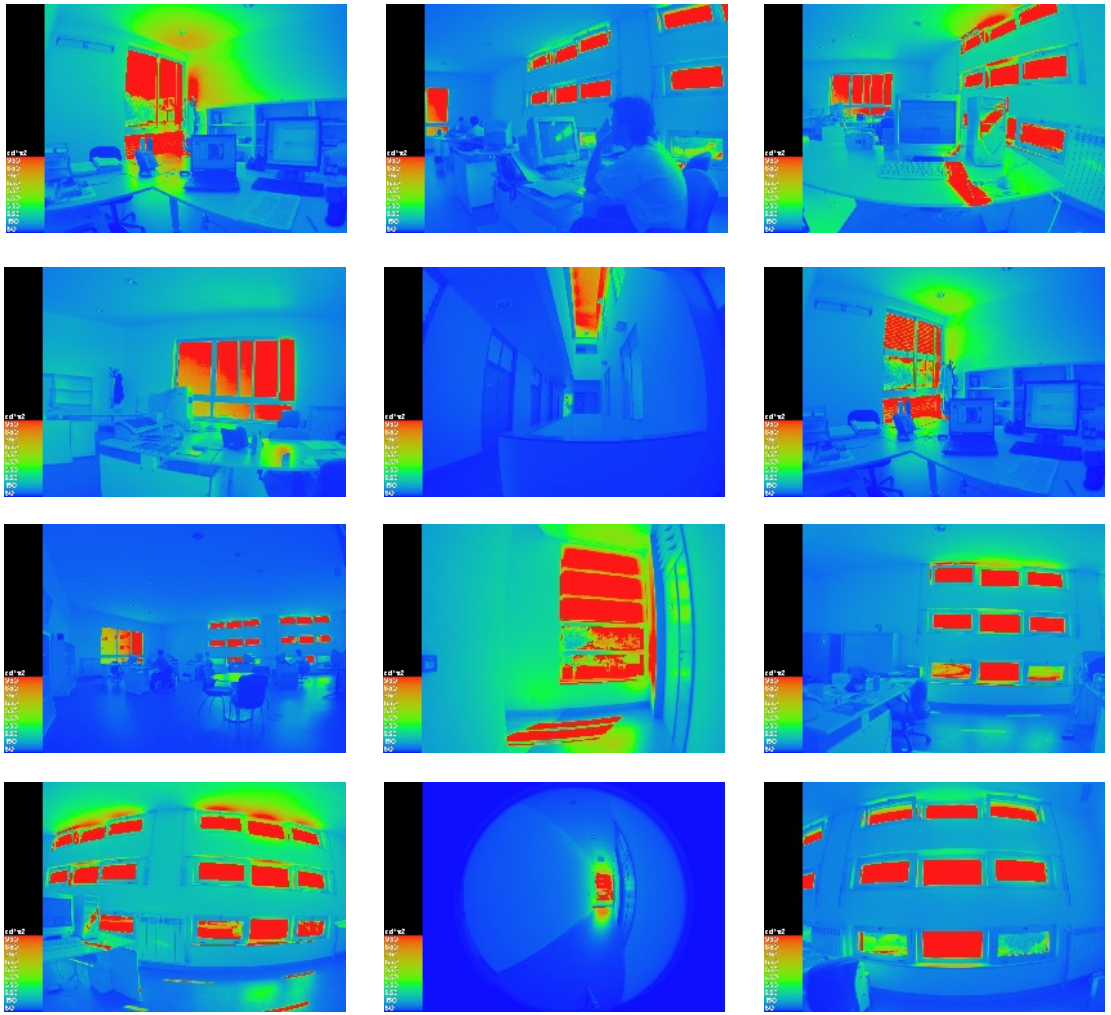
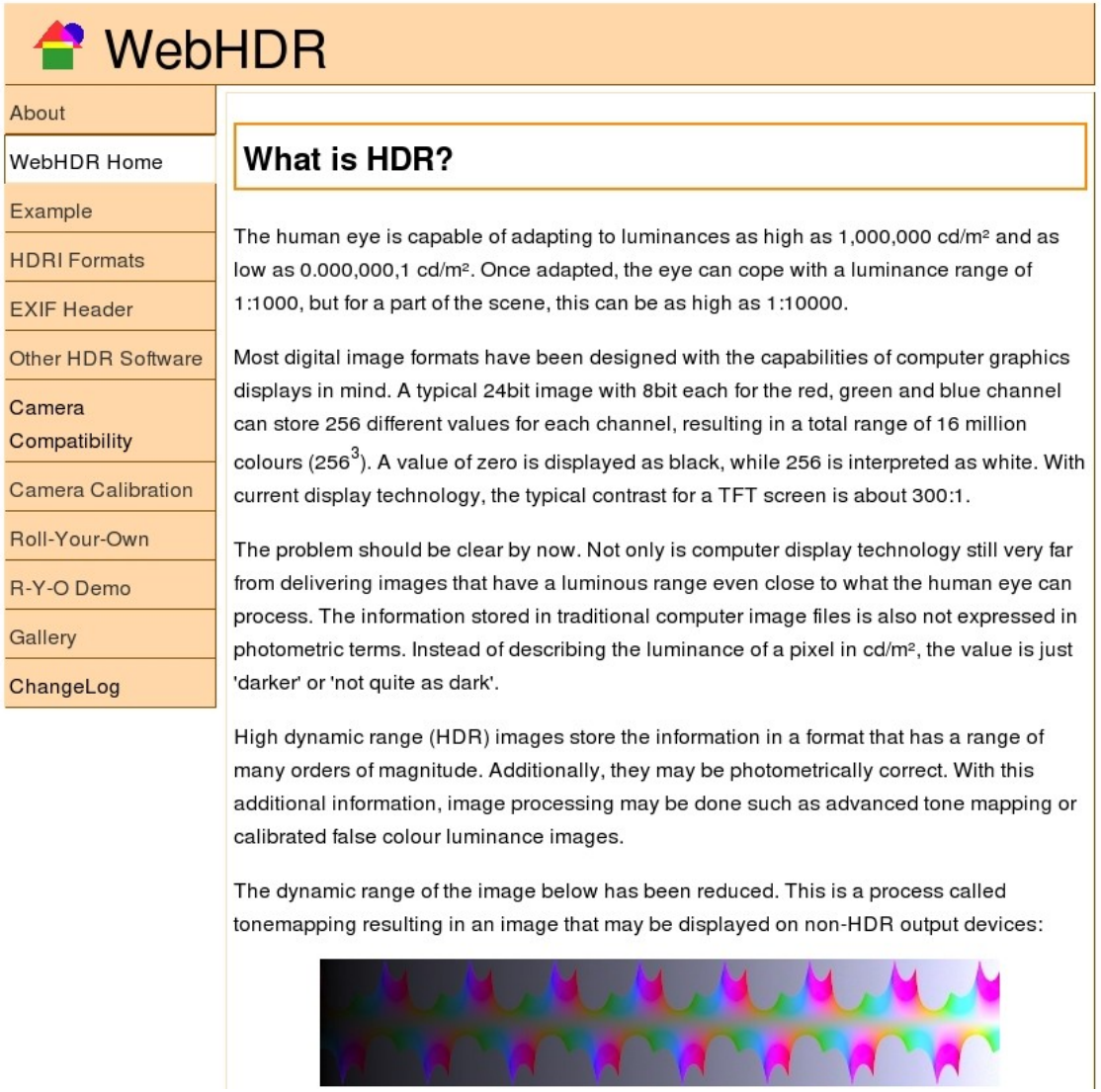


Reasons

- Provide an on-line facility for HDR imaging creation
- Graphical web interface
- Front-end to hdrgen command-line
- Front-end to Radiance programs (pfilt, ximage)
- Provide students/non-experts with a free tool for HDR
- Give immediate feedback in terms of luminance

WebHDR home

Gives general information on high dynamic range images



Example

Images taken with a digital consumer camera with different exposure settings.
Preferrable to change exposure time rather than aperture.

Example

The images below were taken with a Nikon Coolpix 995 digital camera. The built-in exposure bracketing allows to take a series of 5 images which can be be up to +/-2 f-stops under or over exposed.

The exposure-bracketed images can be assembled into one high-dynamic range (HDR) image. This image has a much higher range of brightness values that it can store. The images in the animation below are produced from the same HDR image in RADIANCE' RGBe format. The exposure can be set interactively in the ximage viewer which is part of the RADIANCE suite of programs.

Exposure +/-0 f-stops

Modern digital cameras store additional information in the JPEG file they produce. This includes details about the camera, as well as exposure values and a thumbnail preview. The information is kept in the header of the file and is stored in EXIF format.

Formats

A list of HDR image formats (not extensive)

HDR Image Formats

Pixar's Log Format

Pixar has recognized the need for dynamic range in film recording, so they developed a 33-bit/pixel log encoding for RGB values, which is implemented as part of Sam Leffler's TIFF library. The encoding covers about 3.5 orders of magnitude, with 0.4% relative accuracy.

RADIANCE's RGBE Format

Since it's inception in 1987, the RADIANCE rendering system has used a 32-bit/pixel floating point format. The image format is described on the RADIANCE web site. The encoding covers about 76 orders of magnitude with 1% relative accuracy.

SGI's LogLuv Format

Sam Leffler's TIFF library includes a codec for a 32-bit/pixel logLuv encoding. Compared to the RADIANCE and Pixar encodings, this has the advantage of covering the full gamut of perceivable colors in imperceptible steps. The luminance range covers 38 orders of magnitude with 0.3% relative accuracy, and chroma errors never reach the visible threshold.

Industrial Light and Magic's OpenEXR

The file format was developed to overcome the limited dynamic range and colour precision in computer imaging applications. The specifications were published under an Open Source license, software and libraries are available under a modified BSD license.

Formats

HDR Image Formats

Images are usually store in 24- bit JPEG format with 8 bit for each Red, Green and Blue channel.
2^8=256 for each channel or
$2^8 \times 2^8 \times 2^8$ = 16 000 000 in total

it may seem a lot but it is still far from the entire dynamic range the humam vision can addapt to.

A number of file formats aim to overcome the gamut and dynamic range limitations of JPEG output by digital cameras.

Comparison

Format	Dynamic Range	Accuracy	Bits/pixel
RADIANCE RBGE	76	1.0%	8R + 8G + 8B + 8E
Pixar Log TIFF	3.8	0.4%	11R + 11G + 11B
LogLuv 24-bit	4.8	1.1%	10logL + 14(u',v')
LogLuv 32-bit	38	0.3%	16logL + 2x8(u',v')
ILM OpenEXR	9.6	0.1%	16R + 16G + 16B
TIFF 48-bit	5.4	1.0%	16logR + 16logG + 16logB
IEEE TIFF 96-bit	79		32R + 32G + 32B

HDR Software

Lists other software for HDR, presenting their capabilities in terms of :

- HDR images
  - create
  - edit
  - view
- supported opperating system
  - Linux
  - Windows
  - Mac
- Price/Licence
  - Free
  - No cost
  - Commercial

PFSTools

PFSTools is a set of command line (and one GUI) programs for reading, writing, manipulating and viewing high-dynamic range (HDR) images and video frames. All programs in the package exchange data using a simple generic file format (pfs) for HDR data. The concept of the pfstools is similar to netpbm package for low-dynamic range images.

Formats	Capabilities	Systems	License
RGBE, FP TIFF, OpenEXR, PFM, LogLux TIFF			

CinePaint

CinePaint, formerly known as Film Gimp is a fork of the popular GPL image editor The Gimp. The main target groups are the film industry as well as professional photographers that require a colour depth higher than that available with standard image editors.

Formats	Capabilities	Systems	License
RGBE, FP TIFF, OpenEXR and many more...			

Greg Ward's hdrgen

hdrgen is the HDR composition engine behind Photosphere and WebHDR. Pre-compiled binaries are available for a number of platforms. Like it's bigger brother Photosphere, the images are auto-aligned to compensate for camera movement.

Formats	Capabilities	Systems	License
RGBE, LogLuv TIFF, OpenEXR			

RADIANCE

RADIANCE is a highly accurate ray-tracing software system. It produces synthetic HDR images and is capable of manipulating HDR images.

Formats	Capabilities	Systems	License
RGBE, TIFF			

Calibration

Camera calibration

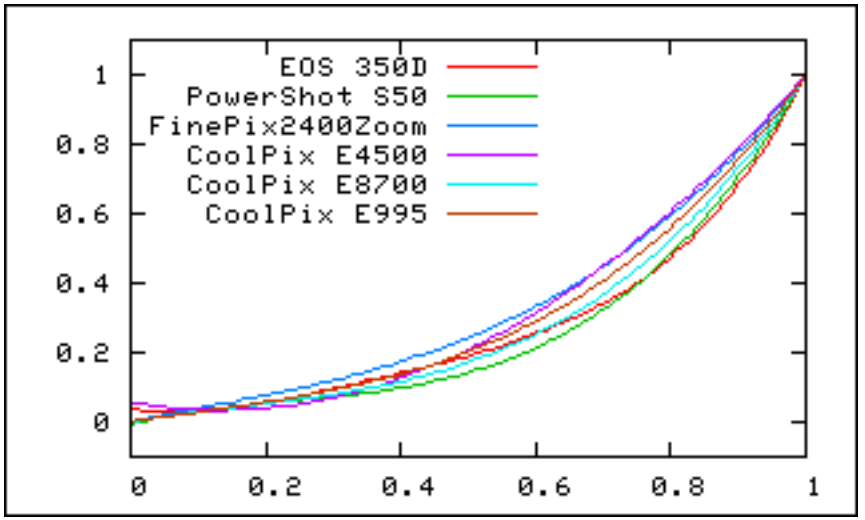
While hdrgen does quite a good job in trying to make the luminance information as accurate as possible, it is reliant entirely on the EXIF information in the JPEG files. The results, however, depend on many variables which the software can't evaluate.
To add to the complication, even cameras of the same make and model exhibit differences in the response curves of their photo-sensitive chips. After all, consumer digital cameras were never meant to measure luminance values accurately.

Calibration

Camera response curve

How to aquire the response curve:

- use Automatic Exposure Bracketing only when in Aperture Priority mode. If not addopt Manual mode.
- Turn off Automatic White Balancing and set the White Balance to the predominant light source.
- Disable all colour and contrast enhancing features.
- Use a tripod.
- If possible, use a remote shutter control.
- Choose a scene with large grey or white surfaces.
- The scene should have very bright and very dark areas.
- Take a sequence of exposure bracketed images separated by 1 EV. This is equivalent to halving or doubling the exposure.
- The darkest exposure should have no RGB values above 200, while the lightest exposure should not contain values below 20. When uploading the sequence, do not include images that are outside of this.



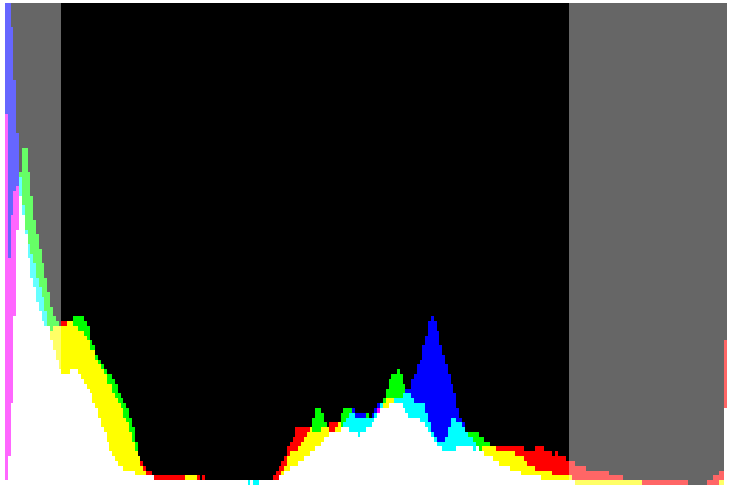
Calibration

- The grey borders on either side of the black background indicate the bands below 20 and above 200. Black pixels are to the left, white ones on the right. Pixels that are completely black or white (i.e. that have values of 0 or 256) are excluded from the histograms.
- This makes them easier to read for extreme exposures.
- The response curve is a polynomial. It's coefficients are stored in a text file with the extension **.rsp** that might look like this:

3 1.57501 -1.01875 0.462603 -0.0188579
3 1.54919 -1.01298 0.480414 -0.0166318
3 1.49544 -0.897716 0.414424 -0.0121498

luminance = 1.57501x3 - 1.01875x2 + 0.462603x - 0.0188579.

Camara response curve



Once the camera's response curve is known, it may be re-used for successive runs of WebHDR. In general, cameras that allow a great deal of manual adjustment are best suited for this.

Calibration

Absolute calibration

For an absolute photometric calibration:

1. Produce a HDR image of a scene following the instructions above. Experiment until you get no error messages or warnings back from WebHDR.
2. With a luminance meter, measure the luminance in your scene at a few points. Use uniformly lit objects in the scene, such as sheets of paper of various reflectance. The actual reflectance doesn't need to be know. Note down the measured luminances, and save the RSP file for your camera.
3. Determine the luminance in the HDR image.
4. You now have two readings: one from the real scene, the other from the HDR image. Ideally, the two should be the same, and if indeed they are (within a few percent), then you are lucky and done.
5. Compute the **calibration factor**, which is simply the ratio of real luminance over HDR luminance:
   CF = LuminanceReal / LuminanceHDR
   This factor will be around 1.0. If it is way off then something went terribly wrong, and you should start over with step 1.
6. There is a field on the WebHDR upload page that allows you to submit the CF. You should also upload the RSP file which you produced under step 1.

HDR Engine

The demon starts the hdrgen program in the background and makes the link between Apache and hdrgen to produce the results:

1. hdrgen >> full size HDR
2. correct the exposure – apply the correction factor for luminance calibration
3. scale down Radiance image
4. create an OpenEXR file (from the full size RGBE)
5. normtiff (tone mapping)
6. result *.tiff is converted to *.jpg
7. generate interactive luminance map
8. built HTML results page and overwrite place holder (count down page).

Guidelines

The user is advised to follow some guidelines to have successful results.
The web site provides information about how to take a sequence of pictures to obtain HDR image composition.

WebHDR Roll your own

The back-end software running on this server is Greg Ward's *hdrgen* (see under Software).

Please note that not all digital cameras are supported with this automated process due to flaky implementations of the EXIF information stored in the image header by the camera's manufacturer. If in doubt, check the Camera Compatibility page first.

READ THIS!

In order to produce exposure bracketed images successfully, please follow the simple rules below:

1. Know your camera. Be familiar with the Aperture Priority and Manual modes.
2. Use a tripod or rest your camera against a fence, wall or similar.
3. Try to avoid having objects and people moving through your scene during exposures.
4. Make sure the brightest image in the series is not all white and the darkest one not fully black.
5. Switch off automatic white-balancing as it could lead to incorrect results.
6. Don't post-process the images before submitting them to WebHDR. Use the originals. Most image processing software alters or even discards the EXIF header information which is vital for the software to determine the exposure.
7. If you would like to increase the accuracy of the results, please read up on Camera Calibration.

Yes, I understand everything that is explained above.

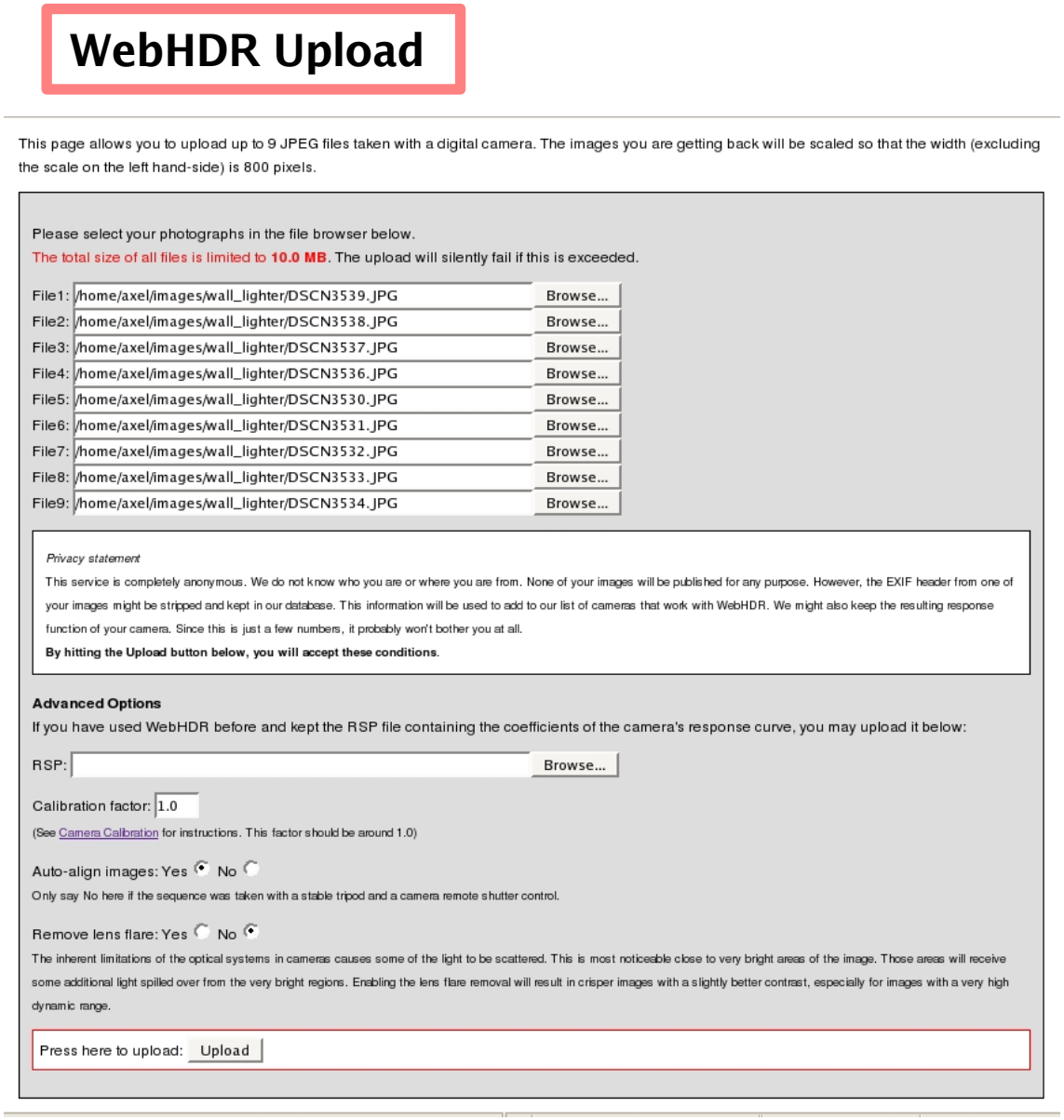
No, this is all too much for me.

Last modified 29 July 2006, 04:05 GMT

Under the hood

When hit “upload” puts the *.jpg into a "**tmp**" directory.
The nomenclature is altered to a sequential number format.

Additionally Apache creates a file in the **spool** directory. The convention name is a “date time” format for later address the **priority spool**. This "**file_spool**" contains information about the **options for the hdrgen** program, namely calibration factor, auto alignment and flare removal.



Engine

Output information on web contains information about:

- calibration
- auto alignment
- no flare

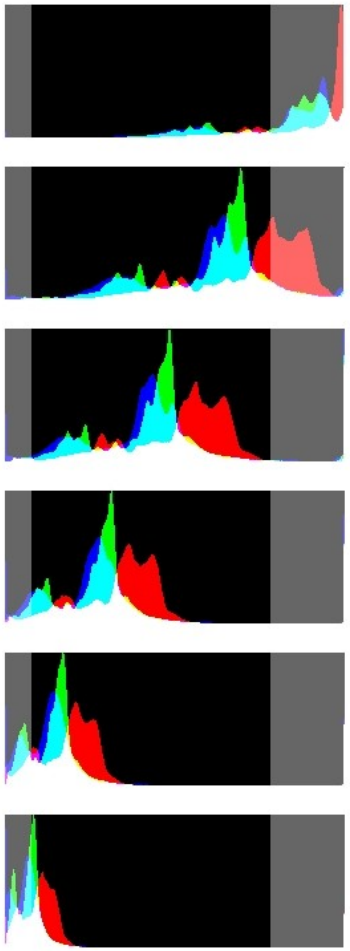
To each file lists the:

- Shutter speed >> Exposure Time
- Aperture >> FNumber
- ISO speed >> ISO

The “tmp”*.jpg are listed with their exposure value (not in use).

WebHDR Upload confirmation

```
Calibration factor is 1.0

Auto-alignment is left on.

DSCN3539.JPG
  MIME Magic: image/jpeg
  Dimensions: 2048x1536 px, Size: 639283 bytes
  Shutter speed: 2.00000, Aperture: 7.5, ISO speed: 100, => Exposure: 4.81
  White balance: Fluorescent

DSCN3538.JPG
  MIME Magic: image/jpeg
  Dimensions: 2048x1536 px, Size: 714446 bytes
  Shutter speed: 1.00000, Aperture: 7.5, ISO speed: 100, => Exposure: 5.81
  White balance: Fluorescent

DSCN3537.JPG
  MIME Magic: image/jpeg
  Dimensions: 2048x1536 px, Size: 669708 bytes
  Shutter speed: 0.50000, Aperture: 7.5, ISO speed: 100, => Exposure: 6.81
  White balance: Fluorescent

DSCN3536.JPG
  MIME Magic: image/jpeg
  Dimensions: 2048x1536 px, Size: 639682 bytes
  Shutter speed: 0.25000, Aperture: 7.5, ISO speed: 100, => Exposure: 7.81
  White balance: Fluorescent

DSCN3530.JPG
  MIME Magic: image/jpeg
  Dimensions: 2048x1536 px, Size: 701568 bytes
  Shutter speed: 0.12500, Aperture: 7.5, ISO speed: 100, => Exposure: 8.81
  White balance: Fluorescent

DSCN3531.JPG
  MIME Magic: image/jpeg
  Dimensions: 2048x1536 px, Size: 642659 bytes
  Shutter speed: 0.06667, Aperture: 7.5, ISO speed: 100, => Exposure: 9.72
  White balance: Fluorescent
```



Engine

Exposure is calculated from the previous values.

If the exposure is missing it gives an error message and doesn't continue further.

Exposure

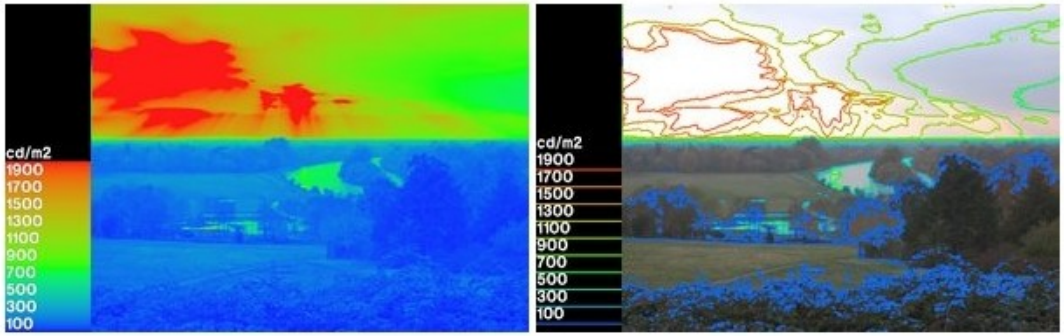
To determine the expose of an image, the following information is required:

- ISO film speed
- Aperture
- Exposure time

All of this information is stored in the EXIF header information. It is therefore possible to use an HDR image as created from a series of exposure-bracketed images to determine the actual luminance distribution within the photographed scene, although this is not not as accurate as using a calibrated luminance meter or a (very expensive) calibrated CCD camera.

$$Exposure = \log_2 (Aperture^2 * (1/Shutter\ speed) * (ISO\ Speed/100))$$

With this information, false colour images may be created that map the luminance of a pixel to an arbitrarily chosen colour. Usually, blue tones are chosen for dark areas, while red tones indicated high luminances.



Engine

Shutter Speed, aperture and ISO are extracted from the EXIF header with Perl::Image::Exiftools.

Exif Header Information

```
EXIF tags in 'cameras/fujifilm_dx10.jpg' ('Intel' byte order):
--------------------+-------------------------------------------------------
Tag                 |Value
--------------------+-------------------------------------------------------
Manufacturer        |FUJIFILM
Model               |DX-10
Orientation         |top - left
x-Resolution        |72/1
y-Resolution        |72/1
Resolution Unit     |Inch
Software            |Digital Camera DX-10 Ver1.00
Date and Time       |1999:01:01 00:03:00
YCbCr Positioning   |co-sited
Copyright           |ANTHONY    (Photographer) - [None] (Editor)
Compression         |JPEG compression
Orientation         |top - left
x-Resolution        |72/1
y-Resolution        |72/1
Resolution Unit     |Inch
YCbCr Positioning   |co-sited
FNumber             |f/4.2
ExposureProgram     |Normal program
ISO Speed Ratings   |150
Exif Version        |Exif Version 2.1
Date and Time (origi|1999:01:01 00:03:00
Date and Time (digit|1999:01:01 00:03:00
ComponentsConfigurat|Y Cb Cr -
Compressed Bits per |14/10
Shutter speed       |68/10 sec. (APEX: 10)
Aperture            |f/4.1
Brightness          |56/10
Exposure Bias       |0.0
MaxApertureValue    |41/10
Metering Mode       |Pattern
Flash               |Flash did not fire.
Focal Length        |5.8 mm
FlashPixVersion     |FlashPix Version 1.0
Color Space         |sRGB
PixelXDimension     |1024
PixelYDimension     |768
Focal Plane x-Resolu|2151/1
Focal Plane y-Resolu|2151/1
Focal Plane Resoluti|Centimeter
Sensing Method      |One-chip color area sensor
File Source         |DSC
Scene Type          |
InteroperabilityInde|R98
InteroperabilityVers|
--------------------+-------------------------------------------------------
EXIF data contains a thumbnail (10238 bytes).
```

Software for editing EXIF information

Engine

IF the perl module is successful the EXIF **is rewritten** in a "more standard" format (at least one that hdrgen can interpret, ie aperture=FNumber).

Database

One of the pages with more than 100 entries shows the test of different **cameras** for **compatibility** with ExifTools.

Only 4 out of 114 do not work.

Camera Compatibility

The last column of the table below, titled **Status**, indicates how often that camera model was used with WebHDR. Camera models listed as failed are not suitable for creating HDR images. Many older models don't implement the full set of EXIF header information, so the exposure of the images cannot be determined by the software.

If the field says test o.k., the model has been successfully tested for compatibility, but not actually used for creating a HDRI.

Please help us keep this list up-to-date. If you have access to a digital camera not listed in the table below, we would greately appreciate if you could upload a photograph using the form at the bottom of this page.

#	Make	Model	EXIF	Status
1	Asahi Optical Co.,Ltd	PENTAX Optio 430	EXIF	5 times
2	CASIO COMPUTER CO.,LTD	EX-P600	EXIF	test o.k.
3	CASIO COMPUTER CO.,LTD	QV-R51	EXIF	test o.k.
4	CASIO	QV-5700	EXIF	failed
5	Canon	Canon DIGITAL IXUS 330	EXIF	2 times
6	Canon	Canon DIGITAL IXUS 40	EXIF	1 times
7	Canon	Canon DIGITAL IXUS 400	EXIF	test o.k.
8	Canon	Canon DIGITAL IXUS 700	EXIF	test o.k.
9	Canon	Canon DIGITAL IXUS 750	EXIF	test o.k.
10	Canon	Canon DIGITAL IXUS v2	EXIF	test o.k.
11	Canon	Canon DIGITAL IXUS v3	EXIF	2 times
12	Canon	Canon EOS-1Ds Mark II	EXIF	test o.k.
13	Canon	Canon EOS 10D	EXIF	1 times
14	Canon	Canon EOS 20D	EXIF	3 times
15	Canon	Canon EOS 300D DIGITAL	EXIF	5 times

Engine

The daemon basically looks into the spool directory for a file and when it finds one reads it.

Falsecolor has priority to other HDR processes in queue as the name still maintains the previous “timing” (a new file replaces the old).

The output of *hdrgen* is printed between the two lines below:

```
       Analyzing Images
       Analyzing Images *****
       Analyzing Images **********
       Analyzing Images ***************
       Analyzing Images ********************
phdrimg.cpp:301:warning: Trouble finding HDR patches
       Analyzing Images ****************************
phdrimg.cpp:301:warning: Trouble finding HDR patches
       Analyzing Images ************************************
phdrimg.cpp:301:warning: Trouble finding HDR patches
       Analyzing Images ********************************************
phdalign.cpp:304:warning: Exposure too extreme for alignment
       Analyzing Images ************************************************
phdalign.cpp:304:warning: Exposure too extreme for alignment
       Analyzing Images ************************************************************
       Combining Images
       Combining Images *****
       Combining Images **********
       Combining Images ***************
       Combining Images ********************
       Combining Images ****************************
       Combining Images ************************************
       Combining Images ****************************************
       Combining Images ********************************************
       Combining Images ************************************************
       Combining Images ************************************************************
```

Results

Results presented as:

- RGBE 800x600
- RGBE full-size
- OpenEXR full-size
- False colour image
  - Contour lines
  - Extreme points
- Tone mapped image *.jpg
- Interactive luminance map

Whenever a false colour is re-run the interactive luminance is done as well.

WebHDR Results

Your images are finished. They took 27 seconds to process.

Please download them immediately as they will be removed from our server.

- Hight Dynamic Range image (RADIANCE RGBe, 800x600, 605.15 kB);
- False colour image (JPEG, 900x600, 120.82 kB) [Open in new window];
- Tone mapped image (JPEG, 800x600, 250.37 kB) [Open in new window];

Note: Tonemapping is output-device dependent. This image is optimised for a typical CRT monitor.

- NEW! Interactive luminance map

Note: Requires a recent web browser with JavaScript enabled.

To change the scale and colour of the false colour image, please use the form below to re-submit the result:

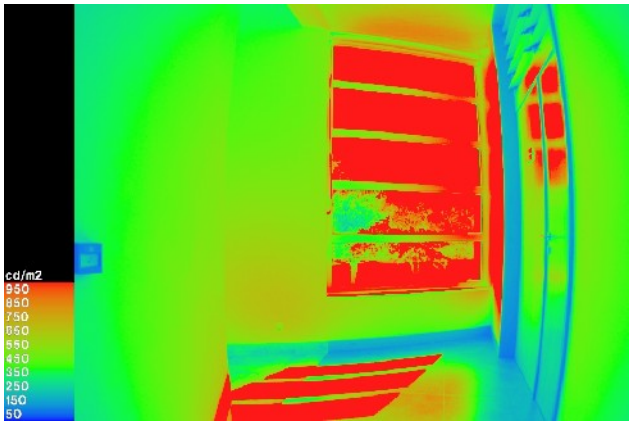
Type of display: false colour print extrema points Yes No

Number of lines/legend entries: 10 with a maximum of: 2000 cd/m²

Mapping: linear logarithmic with 3 decades

Press here to re-submit: Re-submit

NO RESPOSIBILITY IS TAKEN FOR THE ACCURACY OF THE RESULTS.



WebHDR

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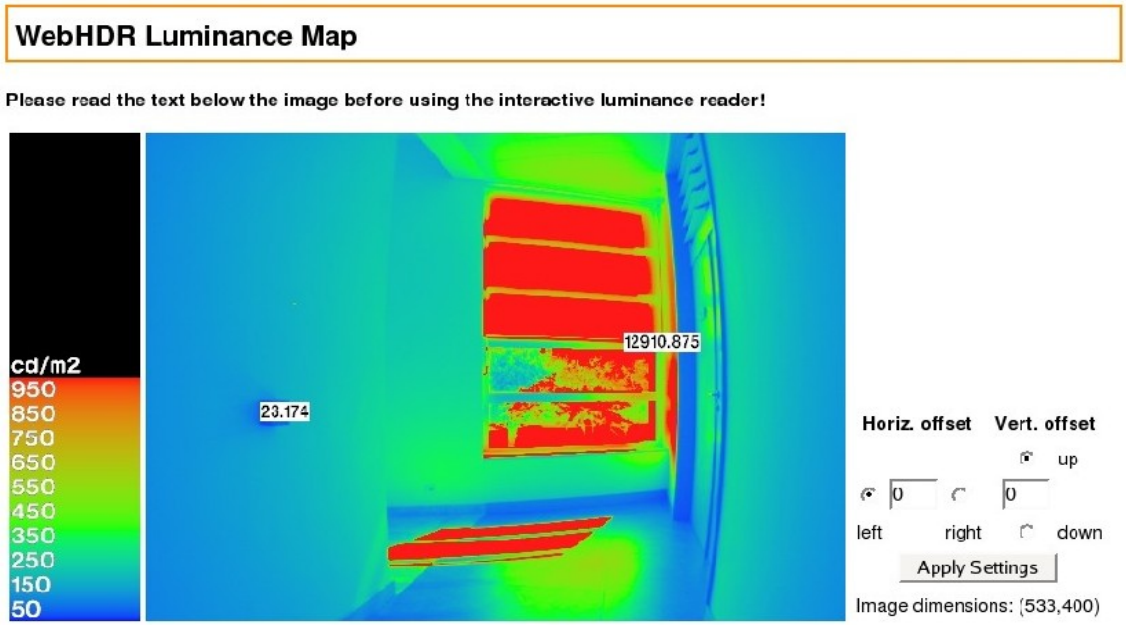
Results

Background engine generates Interactive luminance map:

1. extract **pixel values** with pvalue
2. create **JavaScript** array of pixel values
3. create a **false colour** image
4. **convert** to JPG
5. create HTML **page** for luminance map with java script from 2. linked in
6. add EXIF **information** to database
7. built HTML **results page** and overwrite place holder (count down page).

WebHDR Luminance map



http://luminance.londonmet.ac.uk/webhdr/demo4.html

Conclusions

- WebHDR seems quite popular among architecture students and amateur photographers
- Allows quantification of the luminous environment in a non expensive approach
- Data storage in a HDR format
- Its a free and simple "interface" to an expert tool
- No information that identifies the user is kept, only the EXIF information.

Thank you!

Have a look at: http://luminance.londonmet.ac.uk/webhdr