HDR

Cvičenia z Počítačového Videnia **2**

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HDR

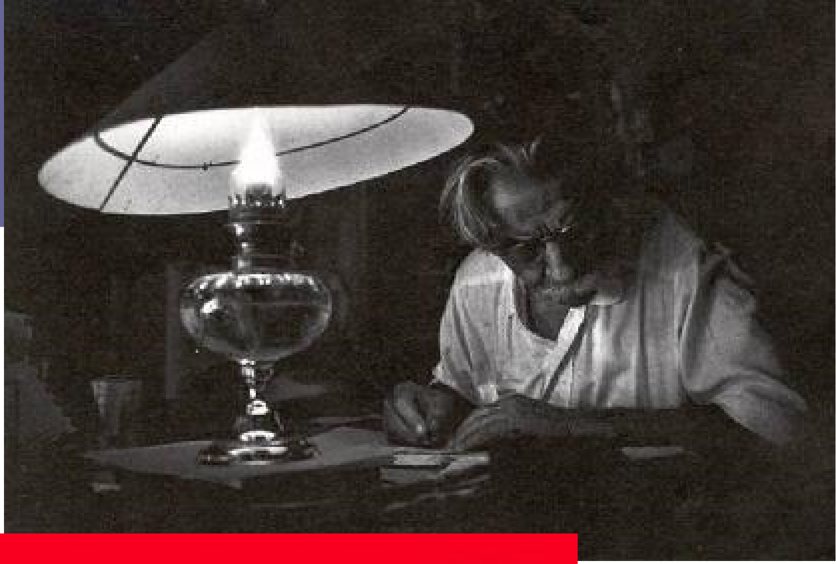
Wide dynamic range allows HDR images to more accurately represent the range of intensity levels found in real scenes, ranging from direct sunlight to faint starlight.

The two main sources of HDR imagery are computer renderings and merging of multiple photographs

Photographs LDR, SDR

Tone-mapping techniques, which reduce overall contrast to facilitate display of HDR images on devices with lower dynamic range, can be applied to produce images with preserved or exaggerated local contrast for artistic effect.

Analogue HDR



Eugene Smith

Ansel Adams

Charles Wickoff

HDR

EV = $$log_2 \left(\text{Aperture}^2 * \frac{1}{\text{Shutter speed}} * \frac{\text{ISO}}{100} \right)$$

EV+1 … s/2 alebo a/√2

EV-1 … 2*s alebo a*√2

Fixná clona a => rovnaká hĺbka ostrosti

shutter times:

¼, 1/8, 1/15, 1/30, 1/60, 1/125, 1/250, 1/500, 1/1000 sec

v skutočnosti:

¼, 1/8, 1/16, 1/32, 1/64, 1/128, 1/256, 1/512, 1/1024 sec

F3.2

F9.0

HDR

In photography, dynamic range is measured in EV differences (known as stops) between the brightest and darkest parts of the image that show detail. An increase of one EV or one stop is a doubling of the amount of light.

Contrast ratio = $2^{(\text{EV difference})}$

EV difference = $\log_2(\text{Contrast ratio})$

Device	Stops	Contrast
Computer LCD	9.5	700:1
DSLR camera (Canon EOS-1D Mark II)	11[4]	2048:1
Print film	7[4]	128:1
Human eye	10–14[5]	1024:1 – 16384:1

HDR

When we photograph a scene, either with film or an electronic imaging array, and digitize the photograph to obtain a two dimensional array of “brightness” values, **these values are rarely true measurements of relative radiance in the scene**.

For example, if one pixel has twice the value of another, it is unlikely that it observed twice the radiance.
There is usually an unknown, **nonlinear mapping** that determines how radiance in the scene becomes pixel values in the image.

Paul Debevec and Jitendra Malik 97

HDR

Paul Debevec
HDR shop

http://ict.debevec.org/~debevec/

HDR

All of these features are simultaneously clearly visible to a human observer standing in the same location, because of adaptation that takes place as our eyes scan the scene

Figure 1: A series of five photographs. The exposure is increasing from left (1/1000 of a second) to right (1/4 of a second).

HDR

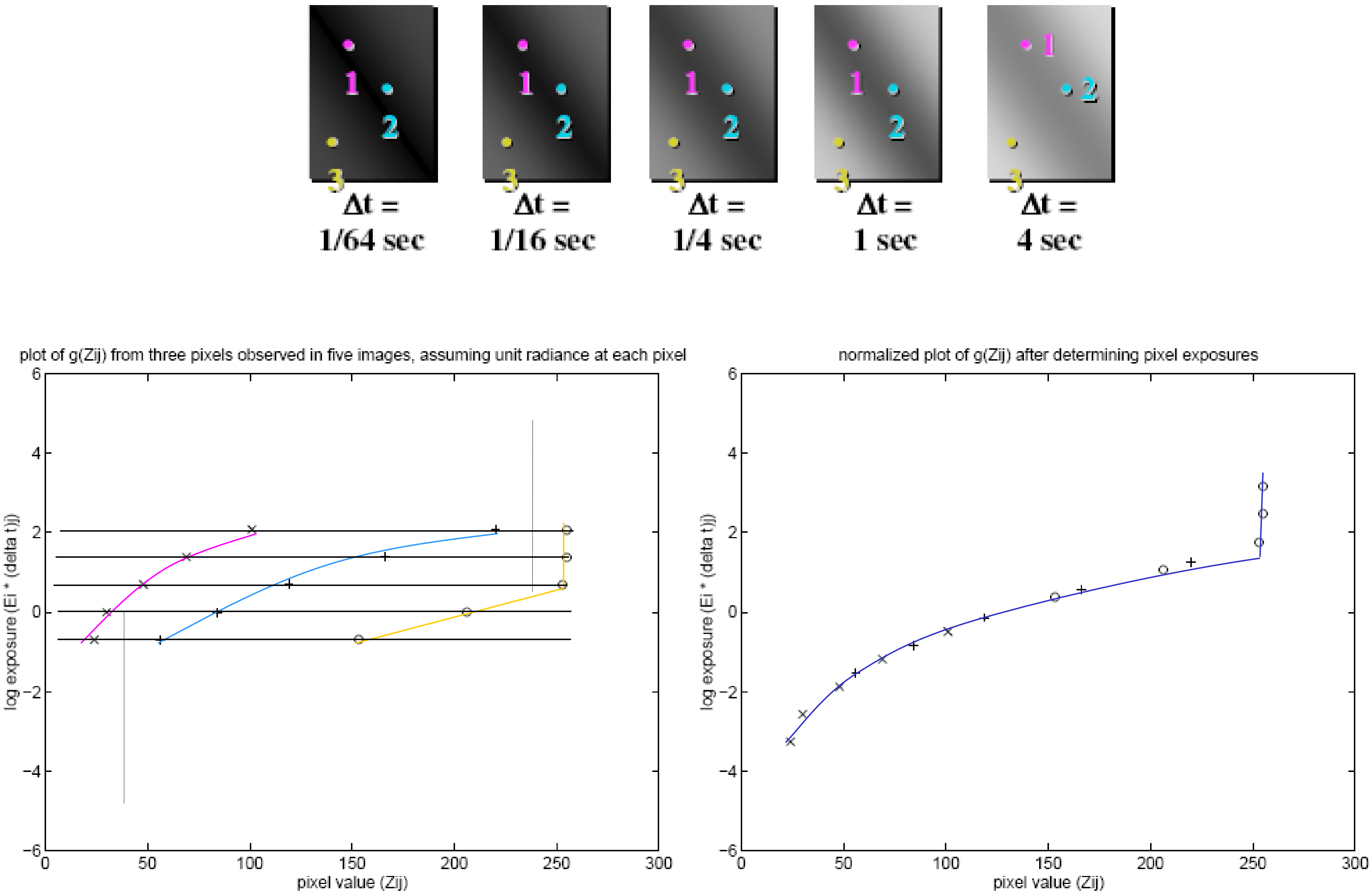
How can we combine these separate images into a composite radiance map?

Figure 1: A series of five photographs. The exposure is increasing from left (1/1000 of a second) to right (1/4 of a second).

HDR

Application:

- Art- Image compositing (different sources)
- Research tool (validation of rendering)


1
2
3
Δt = 1/64 sec
Δt = 1/16 sec
Δt = 1/4 sec
Δt = 1 sec
Δt = 4 sec
plot of g(Zij) from three pixels observed in five images, assuming unit radiance at each pixel
log exposure (Ei * (delta t j))
pixel value (Zij)
normalized plot of g(Zij) after determining pixel exposures
log exposure (Ei * (delta t j))
pixel value (Zij)

HDR

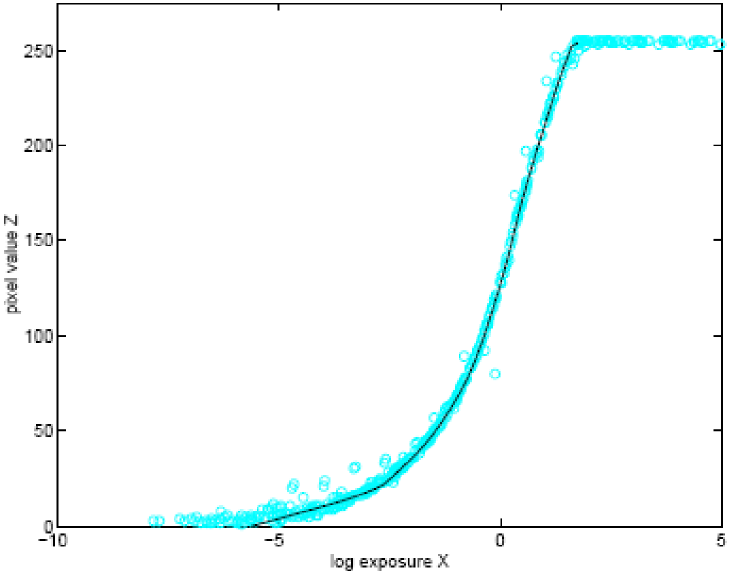


Figure 4: *The response function of the DCS460 recovered by our algorithm, with the underlying* $(E_i \Delta t_j, Z_{ij})$ *data shown as light circles. The logarithm is base* e.

Tone mapping

Contrast reduction
HDR images can easily be represented on common LDR devices, such as computer monitors and photographic prints, by simply reducing the contrast, just as all image editing software is capable of doing.

Clipping and compressing dynamic range
Scenes with high dynamic ranges are often represented on LDR devices by **cropping the dynamic range**, cutting off the darkest and brightest details, or alternatively with an S conversion curve that compresses contrast progressively and more aggressively in the highlights and shadows while leaving the middle portions of the contrast range relatively unaffected.

Tone mapping

Spatial resolution and **Tonal resolution**. The spatial resolution is related to the number of pixel locations (u, v) in the image. The tonal resolution is related to the number of bits in the representation and the set of possible values for each color component (c1, c2, c3) of c.

Tone mapping reduces the dynamic range, or contrast ratio, of the entire image, while retaining localized contrast (between neighboring pixels), tapping into research on how the human eye and visual cortex perceive a scene, trying to represent the whole dynamic range while retaining realistic color and contrast.

Tone mapping

Various tone mapping operators have been developed in the recent years [1]. They all can be divided in two main types:

* **Global** (spatially uniform) operators: they are non-linear functions based on the luminance and other global variables of the image.

Every pixel in the image is mapped in the same way, independent of the value of surrounding pixels in the image.
Simple and fast
Can cause a loss of contrast.
Example: contrast reduction

Tone mapping

Various tone mapping operators have been developed in the recent years [1]. They all can be divided in two main types:

* **Local** (spatially varying) operators: the parameters of the non-linear function change in each pixel, according to features extracted from the surrounding parameters.

Effect of the algorithm changes in each pixel according to the local features of the image.
Algorithms are more complicated
Can show artifacts (e.g. halo effect and ringing),
Output can look un-realistic,
Can provide the best performance, since the human vision is mainly sensitive to local contrast.

Tone mapping

Global vs. Local

Tools

HDR tools:

Photoshop http://www.adobe.com/products/photoshop.html
HDR shop http://ict.debevec.org/~debevec/HDRShop/ free 1.0
HDR sticher http://hdr.danielpohanka.com/index.html free
Photomatix http://www.hdrsoft.com/ free trial
…

MATLAB Image processing toolbox

Úloha c. 3

Skladá sa z 3 úloh, každá za 5 bodov
vyberte si ľubovoľné 2 a pošlite riešenie
do 8.5. do 23:59,

BONUS:

Kto pošle úlohy do 1.5. do 23:59 dostane +1 bod za účasť
(Pripomínam že za účasť je max 10 bodov)

Úloha c. 3

Úloha 3/1: RANSAC

Rozšírte svoju úlohu č. 2 o implementáciu RANSACu.

Vytvorte presnú mapu výskytu Horalky, tak že zistíte presnú transformáciu medzi vzorovým obrázkom Horalky a Horalkou na vstupnom obrázku.

Typ: Použite Ransac a vypočítajte Homografiu pomocou ktorej potom zistíte polohu rohov Horalky a vykreslíte štvoruholník

Úloha c. 3

Úloha 3/2: Processing

Vytvorte aplikáciu v processingu **s využitím kamery**.
Dvôležitá je originálnosť a nápad

Vytvorte applet, umiestnite na svoju stránku spolu s krátkym popisom a pošlite link.

Úloha c. 3

Úloha 3/3: Akoze HDR

Vytvorte funkciu ktorá z 3 obrázkov vytvorí obrázok, ktorý bude mať väčší dynamický rozsah.

Pre obrázky sa nebude zadávať hodnota expozície a ani to ktorý obrázok je najmenej a najviac exponovaný.

Poznámka:
Nepoužívajte funkcie na vytváranie hdr ani na tonemapping.
Zistite najskôr poradie obrázkov z hľadiska expozície
Skúste do stredného obrázku pridať tmavé a svetlé detaily z ďalších dvoch.
Nemusíte vytvárať žiadne GUI