TONEMAPPING & HDR

Dynamic Range

- device specific but always very limited

camera ~ 1:1000

human (w/ after adaptation steps) 1:1 000 000 000

High Dynamic Range (HDR) Imaging

Usually acquire HDR images w

Exposure bracketing

↳ capture additional over- & underexposed images

basic idea: combine multiple images

use available sequence dyn range

pick for each px best exposed img

don't change aperture, only exposure time

OECF Test chart

- absolut calibration target
- know abs. outside luminance → what each value can is representing

OECF Test chart
- absolut calibration target
- know abs. outside luminance → what actual values can is reporting

→ w/o test chart don't know relationship between physical & digital values

imgs + response curve
↓
linearized imgs
| + scaling
| + weighting func
↓
floating point HDR img

1134 - 1155
more math

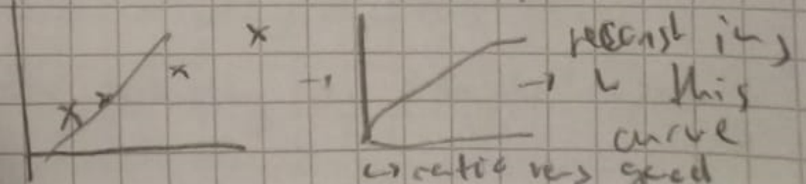
Robertson
Principle:
- scale HDR img using response curve
- find better response curve using HDR img } - find irradiance - recover response curve
→ iterate until converged curve

same point @ diff exposure times = using diff HDRs ← rand points!

over/underexposed values → all 1/0
→ new curve

! assume lin response curve → all diffs due to exposure time

Recover: - find px w same avg
- assume known HDR
- any exposure



weighting func (can be added for more robust results)

eg Gauss - clip to 0 in over/underexposed

- motivated by general noise model

Gauss Seidel → use for optimisation (lowest error)

better values ?

better curve

Robertson Algo Discussion

- easy method
- no assumptions about curve shape
- converges fast (usually 5 iterations), uses all input data
- can be extended to >8 bit color depth
- 16 bit should be followed by smoothing

Input Imgs for Response Recovery

- should cover full range of radiance values
- ⊕ - uniform histogram of values

best: out of focus smooth illum gradient → not too many high freq

- Abbr should be followed by smoothing

Input imgs for Response Recovery

- should cover full range of radiance values
- ⊕ - uniform histogram of values
- - no color processing or sharpening in result

best: out of focus
smooth illum gradient
→ not too many high freq

How many imgs for good HDR img?

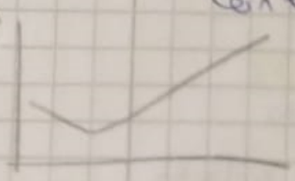
- depends on scene & quality requirements
- mostly: difference of 2 stops (factor of 4) between exposures is sufficient

play around w exposure time
sensitivity

TONE MAPPING (TM)

scaling based

Contrast



Detection Threshold - smallest detectable

Discrimination Threshold - see smallest diff between 2 similar signals (they're more sensitive here)

Why TM?

reduce radiance of img to available from device

Goal: - compress dyn range of img

- reproduce human perc to match real scene

Heuristic Approaches

scaling/clipping → abs. brighter spots lost

better: logarithmic scaling

Tumblin / Rushmeier Approach

- model of observer (only luminance)
- requirement: real / tick display img should be perceived the same
- comp TM w concatenation & inversion of operators

Maintaining Contrast

- contrast based scaling factor
  - maintain visible contrast & just noticable contrast
  - → find scaling factor
    - ↳ JND from real world transform into JND digital

⊖ - single factor for all img

we don't perceive abs. diff in luminance

- there still is clipping at brightest
- adaptation mainly on "layer" level

HISTOGRAM-based GLOBAL TONE MAPPING

idea: find distribution of color diffs most optimal for display

comp adjusthment ing - avg over 1 degree regions

comp histo ot ing - binning of luminance values
→ cumulative histo
crop max increase
→ smooth mapping func

Adjusthment ing ing - box like non-overlapping regions of 1 deg ∠

cumulated → equalited histo

↳ Naive Histo Adjusthment

can add:

Glare - very bright LS affects neighboring px
- impacts adaptation WL
- can simulate w blurring/smoothing in LS reg

less of color in dark scenes
/res

always some loss, choose where it impacts

PARTIALLY LOCAL TM BILATERAL FILTERING

adapt contrast locally

Gamma correction

colors ok, intensity blurred
↳ can separate

Clip

compress low freq
keep high → boost local contrast
same color but: halos! artifacts

Bilateral

non-lin filtering

separate detail from img

intensity | large scale - reduce contrast
= orig - detail
detail - keep
= bilat filter
color - same

LOCAL TM

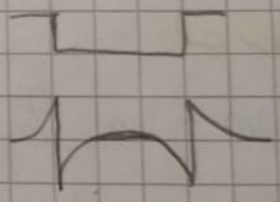
enhance local contrast
preserve global reference
↳ by measuring at several feature scales

Reference HDR img → Measure lost contrast at several feature scales ← TM img
↓
Enhance lost contrast in TM img
↓
enhanced TM img
- communicate lost img contents
- maintain img appearance

↳ similar MipMap or Laplacian

Adaptive Counter shading

Cornsweet illusion



- easily enhance global contrast perc

similar to unsharp masking

↳ use to store perceived contrast of HDR
↳ compressed range of TM img

can also use for texture

boost img at all scales

HDR Displays

e.g. Projector like LCD screen

adjustable backlight