A New Smart Phone Applications for HDR Images Assembly and Some Daylight Analysis

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Low Dynamic Range (LDR) images

Since all regular cameras have limitations in that they cannot capture a large dynamic range of luminance in a realistic scene,
High Dynamic Range (HDR) images

Since all regular cameras have limitations in that they cannot capture a large dynamic range of luminance in a realistic scene, we need to assemble a sequence of LDR (low dynamic range) photos taken by them to create a HDR (high dynamic range) image which includes the whole range.
High Dynamic Range (HDR) images

In a photo realistic HDR image, each pixel corresponds to a realistic luminance value.

For creating a luminance based HDR image we need:
- Tripod (to take photos with different exposure values)
- Manual Settings in Digital Cameras
- Fix aperture (usually F8 or F11)
- Fix ISO: (usually 100)
- Fix white balance (usually daylight)
- Switch off other post processing functions

Or use RAW files instead of JPEGs
High Dynamic Range (HDR) images

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Advantages, Disadvantages and Errors:

When taking HDR photos with DSLR cameras:

Probable errors:
- Image mis-alignment due to movement of camera
- Changes in direction and/or level of (natural) light during capturing process
- Lens vignetting effects
- Lens flare effects
- Luminous overflow
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**Some advantages:**
- The possibility to use different lenses (such as a variety of fisheye lenses, etc.)
- In case of using a full frame sensor DSLR cameras with higher resolution the quality and accuracy can be higher.
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Some disadvantages:
- Needs to have an external computer software (like Photosphere, Aftab, etc.) to assemble LDR photos and create an HDR image ->
  -> So it is not fast to read the lumiance values right after taking photos
Installation file link: http://aftabsoft.net/AftabAlpha/Software/Aftab_Setup.exe

Some tutorials:
http://aftabsoft.net/AftabAlpha
http://aftabsoft.net/aftab-alpha.html
What is available in our smartphones?

- Accelerometers / gyroscope sensors
- GPS sensors
- Camera
- Touchscreen
- Good CPU and Memory

All in one device
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All in one device and it is usually with us
What is available in the Aftab Luminance iPhones app?

- Aperture is fixed to \( \approx 2.2 - 2.4 \)
- Manual exposure settings (from iOS 8 and later version)
  - ISO: 32 - 1600
  - Shutter Speed: (nominally) \( 1/2 \) – \( 1/50,000 \) ???
  - White Balance
- Bracketing
  - 3 or 4 images (based on the model)
- Maximum Exposure step is 3.00

So now, it is possible to have a Physically Based HDR Assembly App

What is available in the **Aftab Luminance iPhones app**?

- Simple tone-mapping
- Reading the pixel or circular area in cd/m²
- Creating linear or logarithmic falsecolor images
What is available in the Aftab Luminance iPhones app?

By enabling this switch, the ISO and white balance are fixed, and the other post processing functions are switched off too

- The number of bracketing shots
- Exposure compensation in Automatic Exposure Bracketing
- The self timer for a delayed camera shutter
- Change the image resolution between the lowest and highest

Change all values from luminance to brightness based on the luminance-brightness power relationship based on an exponent of 1/3 (DiLaura, Houser, Mistrick, et. al. 2011, p. 4.10)

- The number of decades in logarithmic mapping of falsecolor images

Physically realistic HDR image:
Bracketing: 3
Exp. steps: 3.00
Wait. time: 3
Resolution: highest
Show legend in FalseColor page: off
Convert cd/m2 to brightness:
Log decade: 3
Pixel value multiplier: 1
Line / font color: red
What is available in the Aftab Luminance iPhones app?

By drag and drop the HDR files, we can save the HDR files in the phone or the computer via iTunes.
What is available in the Aftab Luminance iPhones app?

Advantages, Disadvantages and Errors:

When taking HDR photos with smartphone apps:

**Probable errors:**
- Image mis-alignment due to movement of camera
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- Luminous overflow

**Some advantages:**
- No needs to have a external computer software (like Photosphere, Aftab, etc.) to assemble LDR photos and create an HDR image ->
  -> So it is easy to read the luminance values right after taking photos

**Some disadvantages:**
- The possibility of using different lenses (such as a variety of fisheye lenses, etc.) is low.
- The quality and accuracy of smart phone camera images sensors is less than DSLR cameras.
What is available in the Aftab Luminance iPhones app?

Applications of luminance based HDR photos?

- Rules and recommendations
  - Measuring the minimum acceptable and preferable background luminance (surrounding walls and ceilings) for the offices (30 cd/m² for the former and between 60 cd/m² and 100 cd/m² for the latter *)
  - Measuring the following luminance ratios for offices*:
    o Between a paper task and an adjacent Visual Display Terminal (VDT) screen: 3:1 or 1:3.
    o Between a task and immediately adjacent surroundings: 3:1 or 1:3.
    o Between a task and remote (non-adjacent) surfaces: 10:1 or 1:10.
  - Measuring the access zone luminance (L20) **
  - Measuring obtrusive light permitted for exterior lighting installation ***
  - Measuring average road luminance and longitudinal uniformity of road surface luminance ****

** The guide for the lighting of road tunnels and underpasses CIE 88:2004
*** The European standard of EN-12464-2 or CIE 150:2003
**** The road lighting European standard of EN-13201
What is available in the Aftab Luminance iPhones app?

Applications of luminance based HDR photos?

- Finding the glass visible light transmission, etc.

- Since brightness and luminance correspond with each other and, as we know, what we see is more relevant to brightness rather than LUX level, performing luminance-based light analysis can be much more helpful in order to understand the lighting conditions of the space in question.

- Considering recently developed physically based lighting calculation tools and HDR assembly software, and their ability to analyze visibility, appearance and visual comfort of any space, lighting designers, researchers, manufactures, codes and standard organizations, etc. can apply luminance based metrics much more than ever before.
What is available in the Aftab Luminance iPhones app?

- Accelerometers / gyroscope sensor
- GPS sensors
- Camera
- Touchscreen
- Good CPU and Memory

The header of the HDR File that is created by Aftab Luminance iPhone App:

```plaintext
2 #trueNorthRotation=420.39
3 #focalLength=4.150
4 #VerSensorSize=3.670
5 #latitude=59.33
6 #longitude=18.06
7 #timezone=-15.00
```
What is available in the **Aftab Luminance** iPhones app?

- Latitude
- Longitude
- Time Zone
- Camera View Point
- Camera View Direction
- Camera View Up Vector
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Clear/Sunny sky

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What is available in the **Aftab Luminance** iPhones app?

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  + Average Reflectance of Interior Space
  
  + Glass Visible Light Transmission Value
  
  + The angle between sun rays and view directions
  
  + Direct Normal Illuminance
  
  + Diffuse Horizontal Illuminance
  
  + Global Horizontal Illuminance

Different skies based on the weather data file

Minimum acceptable illuminance level

\[ Da_{\text{con}} \text{ 300 lux} = \ldots \% \]
The simple formula to estimate the horizontal lux on the camera point

\[
L_{\text{ux}} = \left( \left( \text{Direct Normal Illuminance} \times \cos \alpha \times (\text{openings angle}_{\text{sky}} + \text{openings angle}_{\text{obs}}) \right) \\
+ \left( \text{Diffuse Horizontal Illuminance} \times \text{openings angle}_{\text{sky}} \right) \\
+ \left( (\text{Diffuse Horizontal Illuminance} \\
+ (\text{Direct Normal Illuminance} \times \cos \beta)) \times \text{Reflection}_{\text{obs}} \times \text{openings angle}_{\text{obs}} \right) \right) \\
\times \frac{GVLT}{(1 - \rho) \times 180 \times 360}
\]

- Maximum of Opening Angle is 360 x 180
- \(\alpha\) = The angle between the view direction and sun rays
- \(\beta\) = The angle between the view direction and sun rays
- \(\rho\) = Average material reflection of interior elements
- GVLT = Glass Visible Light Transmission
The simple formula to estimate the horizontal lux on the camera point

\[
\text{Lux} = \frac{(\text{Direct Normal Illuminance} \times \cos \alpha) + \text{Diffuse Horizontal Illuminance}}{1 - \rho} \times \frac{\text{openings angle}}{180 \times 360} \times \text{GVLT}
\]

Maximum of Opening Angle is 360 x 180
\(\rho\) = Average material reflection of interior elements
\(\alpha\) = The angle between the view direction and sun rays
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Applications of sunpath/temporal mapping pages?
- Estimating Sunlight Hours for the camera points
- Estimating available illuminance value on the camera point for the whole year by creating a temporal mapping falsecolor image
- Estimating Continuous Daylight Autonomy on the camera point
- Defining the camera point as daylit, partially daylit or non daylit point
- Check the changes in illuminance availability when playing with varying glass transmission, reflectancy and size of windows
Now, let’s try the app