

High Dynamic Range Imaging & Glare Analysis

I. DEFINITIONS



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HDR Imaging and Glare Analysis

This document is one out of a series of three tutorials that introduce the reader to high dynamic range (HDR) imaging, photography and how to analyze an HDR photo or simulation for potential glare.

The tutorials can be downloaded from the G(SD)² website.



First tutorial that introduces some basic terminology related to high dynamic range imaging.



Second tutorial that shows how to generate a calibrated HDR image using a digital camera, the Photosphere program written by Greg Ward and a luminance meter.

Note: A MAC is needed for this tutorial!



Third tutorial that shows how to analyze an HDR image (photo or simulation) using the 'evalglare' program written by Jan Wienold as well as the Radiance Image Viewer from Autodesk Ecotect written by Andrew Marsh.

Note: A PC is needed for this tutorial!

In This Tutorial

1. What is HDRI?
2. What is Luminance?
3. What is Candela?
4. What is Photometry?
5. What is a CCD Camera?
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What is HDRI?

High Dynamic Range Imaging attempts to represent the full dynamic range of a scene, from direct sunlight to deep shadow. It is a method to digitally capture and edit all luminance (light) in a scene.

Luminance

A photometric measure of the luminous intensity per unit area of light traveling in a given direction. It describes the amount of light that passes through or is emitted from a particular area, and falls within a given solid angle.



The above device is used to measure luminance. The SI unit for luminance is candela per square meter (cd/m^2).

Candela

The SI base unit of luminous intensity. The power emitted by a light source in a particular direction, weighted by the luminosity function (a standardized model of the sensitivity of the human eye to different wavelengths, also known as the luminous efficiency function).

1 Candela =
Approximate Luminous
Intensity Emitted
by One Candle



Photometry

The science of the measurement of light, in terms of its *perceived* brightness to the human eye.

CCD Camera

An image is projected through a lens onto the capacitor array, each capacitor accumulates an electric charge proportional to the light intensity at that location. An analog-to-digital converter (ADC) then turns each pixel's value into a digital value by measuring the amount of charge at each photosite and converting that measurement to binary form.

Glare

Glare is a subjective human sensation that describes 'light within the field of vision that is brighter than the brightness to which the eyes are adapted' (HarperCollins 2002).

Glare is caused by a significant ratio of luminance between the task (that which is being looked at) and the glare source. Factors such as the angle between the task and the glare source and eye adaptation have significant impacts on the experience of glare.

Glare Indices and DGP

A glare index is a numerical evaluation of high dynamic range images using a mathematical formula that has been derived from human subject studies.

Daylight glare probability (DGP) is a recently proposed discomfort glare index that was derived by Wienold and Christoffersen from laboratory studies in daylight spaces using 72 test subjects in Denmark and Germany.

For additional information:

“Evaluation Methods and Development of a New Glare Prediction Model for Daylight Environments With the Use of CCD Cameras”

Jan Wienold and Jens Christoffersen

Harvard Students can download this paper for free, others can download a PDF for a fee or read the abstract for free:

[doi:10.1016/j.enbuild.2006.03.017](https://doi.org/10.1016/j.enbuild.2006.03.017)

HDR as a Daylighting Tool

To use HDR photography technique as a luminance-mapping tool. Multiple exposure photographs of a static scene will be used to capture the wide luminance variation within a scene. The pixel values in the HDR photographs correspond to the physical quantity of luminance in that space with reasonable precision and repeatability. These quantities can then be used for glare analysis. HDR photographs then have the capability to serve as a predictive daylighting tool.

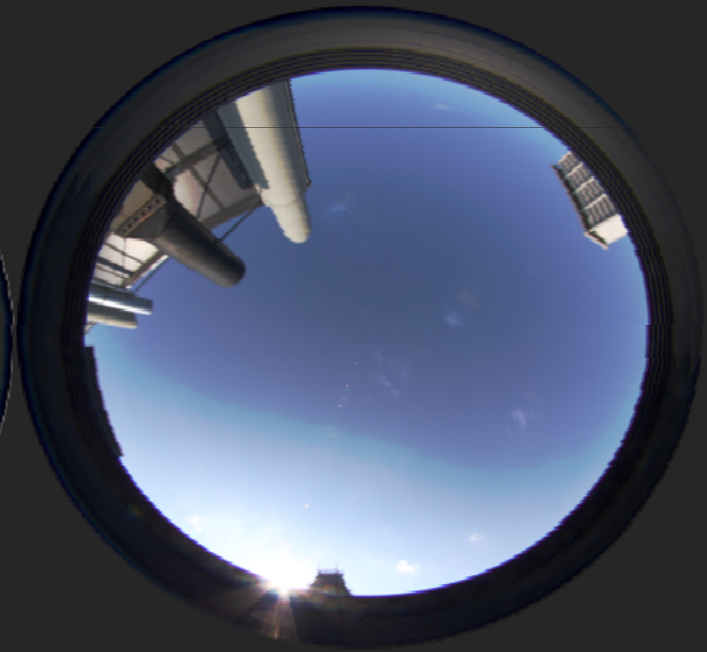
Example HDRIs



Exterior HDRI
(for representation)



Interior HDRI
(for glare analysis)



Sky Luminance Map
(for daylight simulations)

Switch to a MAC to make an HDRI Photo.

High Dynamic Range Imaging & Glare Analysis

II. HDR PHOTOGRAPHY USING PHOTOSPHERE

<http://www.gsd.harvard.edu/research/gsd-square/tutorials.html>

Switch to a PC to begin HDRI Glare Analysis.

High Dynamic Range Imaging & Glare Analysis

III. GLARE ANALYSIS WITH EVALGLARE

<http://www.gsd.harvard.edu/research/gsd-square/tutorials.html>