HDReye™

High Dynamic Range Camera Systems

HDReye™ Model 1
Whole Sphere HDR camera

The Cheshire Engineering HDReye Model 1 is a digital camera designed for full-sphere panoramic high dynamic range image capture. It consists of six cameras with wide-angle lenses arranged on the faces of a cube, along with controlling electronics and a USB 2.0 High Speed interface. It is designed for direct capture of lighting maps for image-based lighting. Other CGI applications include direct capture of reflection and environment maps.

Each camera consists of a 1.2 megapixel color CMOS sensor and a color light meter. The standard lens configuration is 2.9mm f/8.0 in an M12 mount, providing an approximately 145° field of view and a depth of field ranging from about six inches to infinity.

Each camera captures one-sixth of the view. Color information must be applied in post processing, followed by lens corrections and panorama stitching to produce a seamless full-sphere image.

The underlying hardware platform can be customized with from one to six camera sensors. A one-sensor version would make an excellent narrow-field high dynamic range camera requiring a minimum of post processing.

Features & Benefits

- *Automated HDR Imaging*

- *6 Mpixel Whole Sphere Image*
  (Six 1.2 Mpixel CMOS Imagers)

- *10-bit Image Capture*

- *Floating Point Image Processing*

- *Color light meter in each facet*

- *Compact Design (minimizes Parallax)*

- *Rugged Construction*

- *Extended runtime Li-Ion Battery*

- *USB 2.0 High Speed Interface*

Applications

- *Image-based Lighting Models*

- *Reflection Maps*

- *Environment Maps*

Specifications

Sensor technology	CMOS
Color	Bayer pattern RGB mosaic
Physical Resolution	1280 x 1024
Pixel size	5.7μ square
Lens format	1/2" M12 mount
Lens	2.9mm f/8.0
FOV	145° image circle, cropped to sensor
DOF	6in to ∞
Light Meter	Integrated light to frequency
Image size	1024 x 6144 pixels, ~25MB TIFF
Exposure Range	16 stops (1/16000 s to 4 s)
Analog Gain Range	2 stops
RAW format	10-bit pixels
TIFF formats	HDR 32-bit floating point monochrome (25MB)
	HDR 16-bit integer monochrome
	log 8-bit monochrome
Power	80 Wh Li-Polymer battery
	DC 9V to 26V
	Barrel connector
USB	1.1 or 2.0, full or high speed.
	Mini-B connector
Dimensions	3.5in x 3.5in x 3.5in
Mount	1/4 20 tripod thread
Cables	5m USB A to Mini-B bundled with battery cable

High Dynamic Range Images

The dynamic range of an image is the ratio between the brightest and darkest representable pixel values. In the case of a typical 8-bit digital image, this is 255:1, or a dynamic range of about 8 stops. Several units are used to express dynamic range. In photography, the f-stop, stop, or EV is commonly used. One whole stop (1 EV) is a factor of two in exposure.

The HDReye™ is capable of capturing images with a total dynamic range of about 26 stops, achieved with a 10-bit CMOS sensor combined with 16 stops of exposure time control. The captured image is stored in a floating-point representation so that no dynamic range is lost due to the storage format.
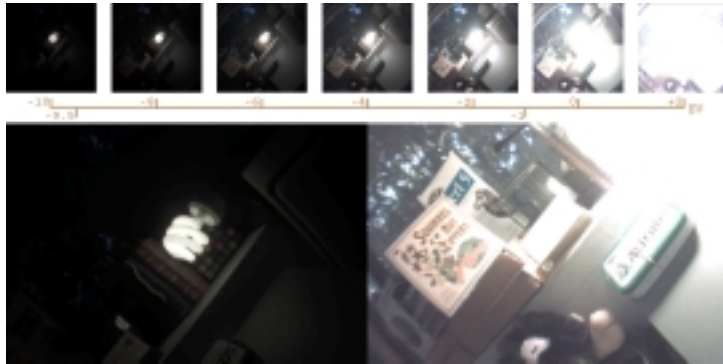
This figure shows several exposures extracted from a single HDReye image. The exposures span a range of 12 stops, and are shown in two-stop increments. The larger images show portions of the field of view at two distinct exposures, showing that usable image detail is available over a wide range of exposures.

Notice in particular that in the darkest exposures the light bulb becomes well exposed, revealing its structure to be a twisty compact fluorescent. A small Macbeth chart can be seen in the background behind the bulb.

In the brighter exposures, the bulb detail is no longer visible, but the rest of the scene is well exposed. Details on the album cover, book cover, and candy tin are will lit.

Full Sphere Imaging

The HDReye Model 1 is constructed as a cube, with a camera and light meter in each face, as shown at right. Each camera takes a wide-angle image, the images include substantial overlap to allow the use of third-party automatic stitching software to produce various panoramic formats.

Automated Imaging

The HDReye Model 1 is designed around a flexible imaging platform that allows the automated collection and analysis of synchronized exposures from up to six imagers. We can create customized geometry and analysis to meet various automated imaging needs, from single-lens to whole sphere.

How it works

When the HDReye's shutter release is activated it automatically takes a sequence of individual exposures. The actual sequence used for the example at left had seventeen exposures ranging from 1/16000 s to 4 s in one-stop increments (none of those source exposures are shown).

The HDReye software computes a geometric mean of the estimated irradiance at each pixel in each exposure. A weighting function emphasizes well-exposed pixels, and excludes fully over-exposed or fully under-exposed pixels from the average. To extend the range into the saturation region of the sensor, the weights are modified in the shortest exposure.

System Requirements

CPU	Pentium 4 at 1GHz
Memory	256 MB
Disk	10 MB for software, driver, and calibration data plus 25MB per HDR TIFF captured
OS	Windows XP

Geometry
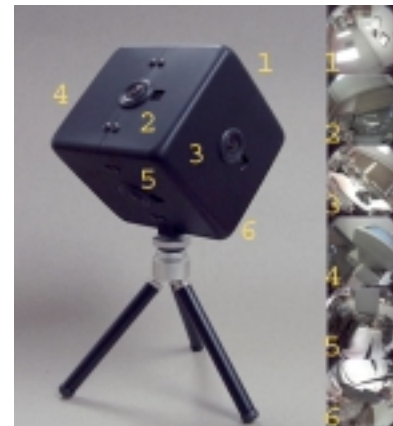
Why the Cat?

When Cheshire Engineering began operations, there were hundreds of companies that named themselves partly with a "micro", "soft", or "tech." Choosing to be more creative and a bit whimsical, one of the founders suggested a name from a favorite character in the Lewis Carroll stories.