

# The Photosphere HDR Image Browser

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Anywhere Software

## Motivation

- Existing browsers are divided in two camps:
  - File browsers with no cataloging features
  - Catalogers with no file browsing features
- None of the existing browsers support HDR
  - High dynamic range imaging considered too special-interest by most software makers
- Philosophical disagreements with the status quo too numerous to mention

## Goals

- Browsing High Dynamic Range Images
  - *Radiance* RGBE format
  - TIFF LogLuv, 16-bit, and float formats
  - Making HDR images from bracketed exposures
- Maintaining Catalog Information
  - Subjects, keywords, albums, comments, etc.
- Tracking Image Files
  - Leave file management & modification to user

## Realized Features

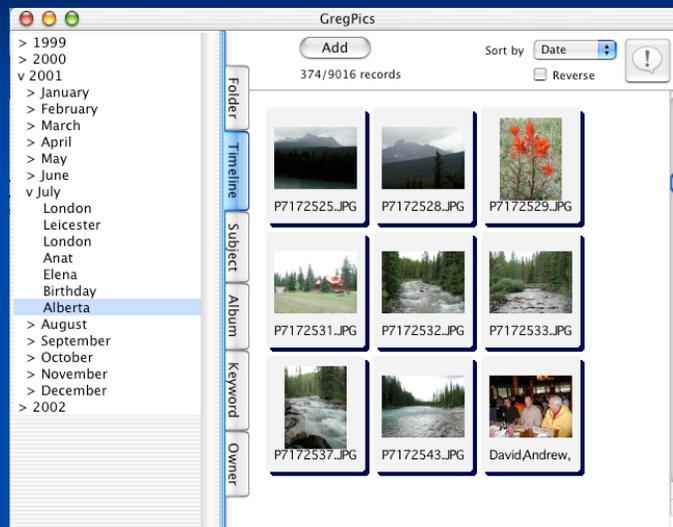
- Fast, interactive response
- Thumbnails accessible when images are not
- Interprets Exif header information
- Builds photo albums & web pages
- Displays & edits image information
- Provides drag & drop functionality
- User-defined database fields

# Unrealized Features

- Accurate color reproduction on all devices
- Plug-in interface for photo printing services
- Linux and Windows versions
- More supported image formats
  - Currently JPEG, TIFF, *Radiance*, OpenEXR

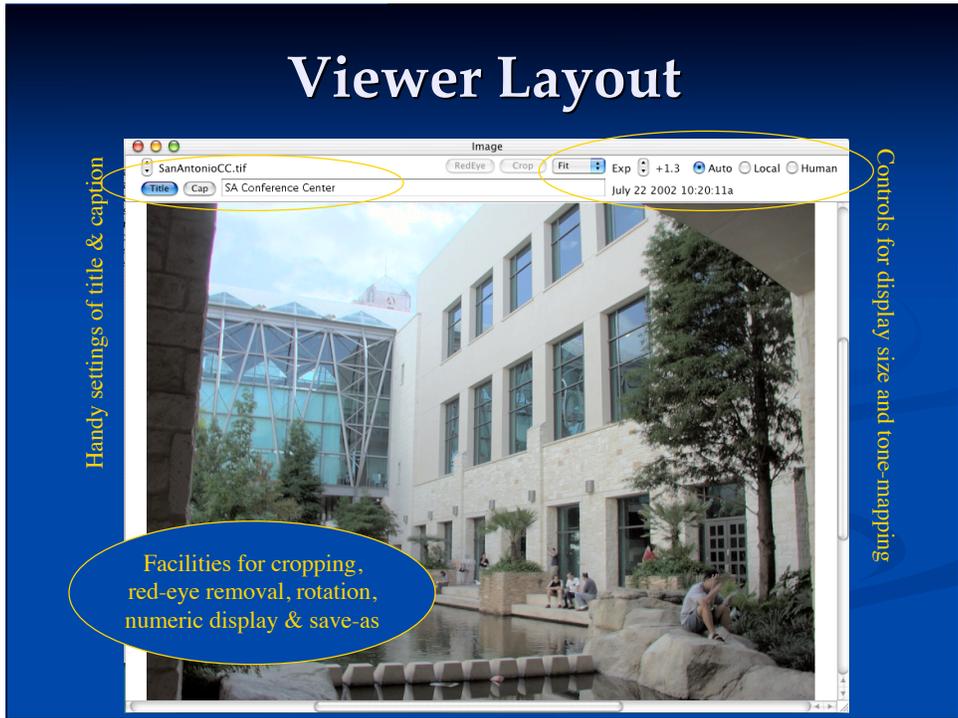
# Browser Layout

Selector Tabs permit multiple image selection from file system or catalog DB

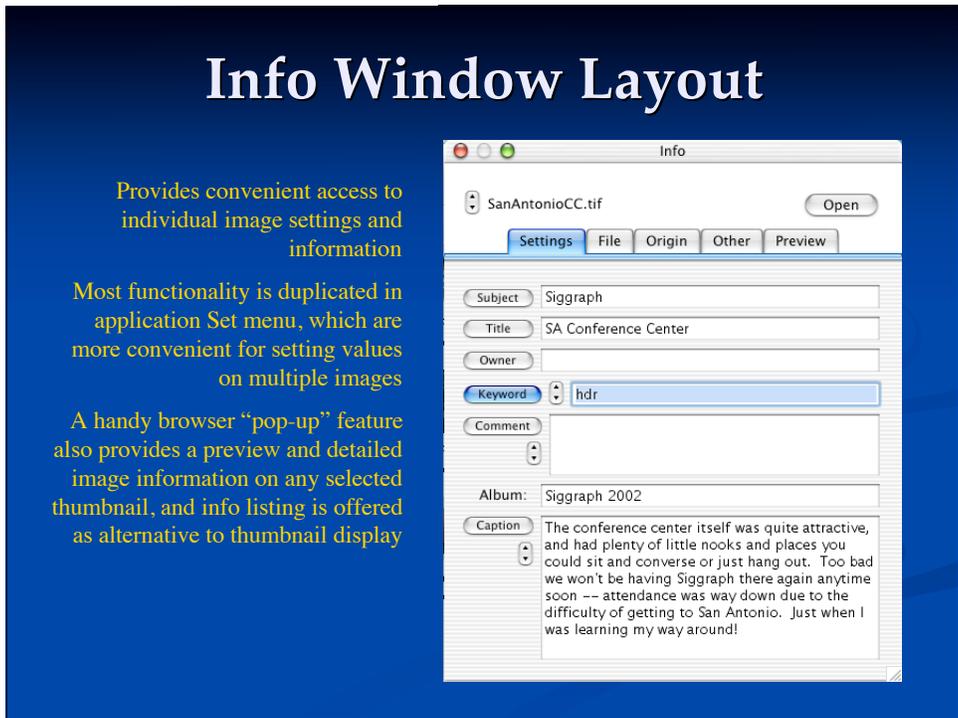


Thumbnail sizes up to 320-pixel resolution preview

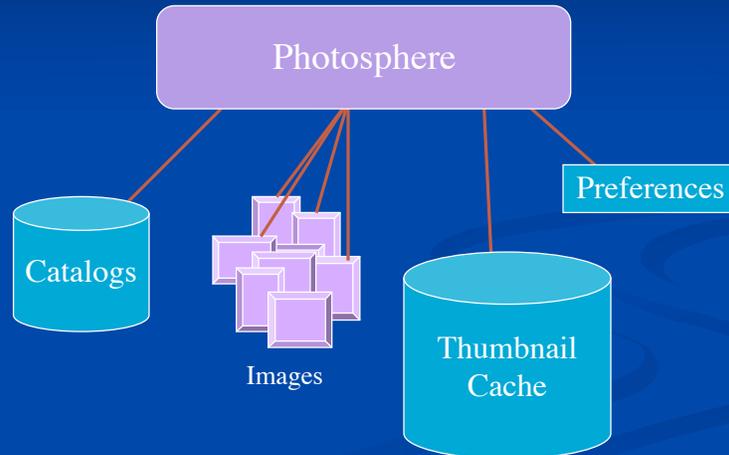
# Viewer Layout



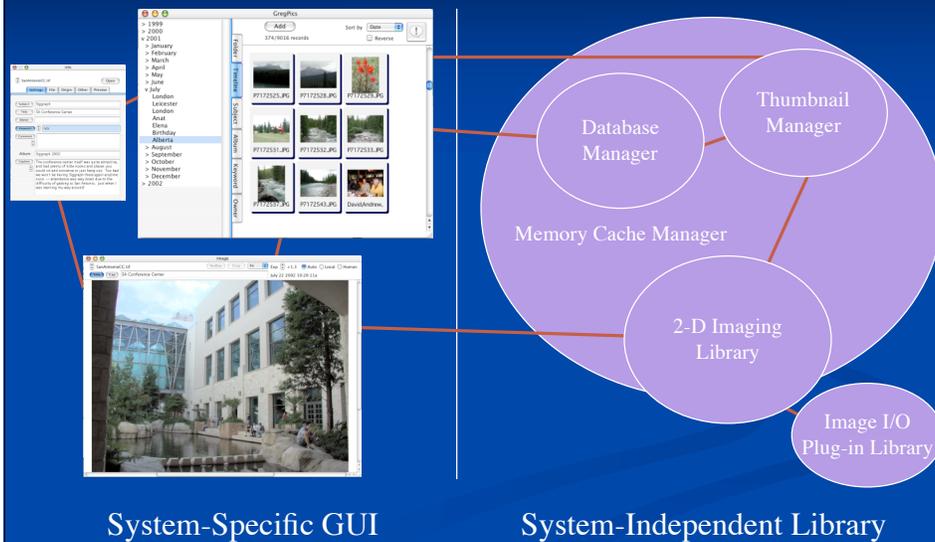
# Info Window Layout



# Browser Files



# Browser Architecture



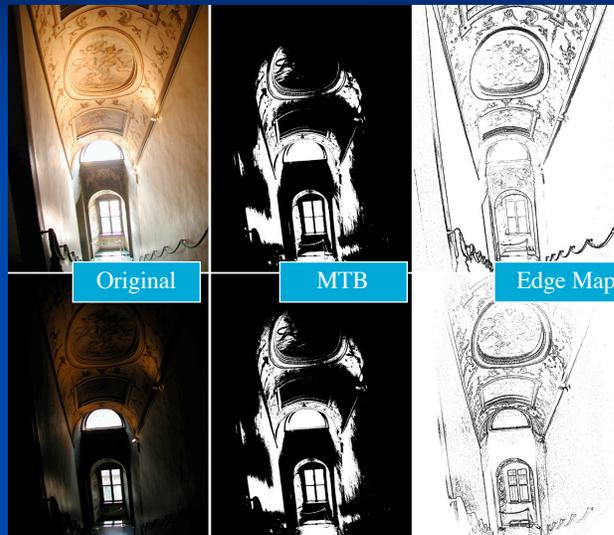
# High Dynamic Range Photography

- Most mid-priced digital cameras offer an “exposure bracket” mode
- Exif header includes exposure information
- Photosphere extracts Exif exposure data
- Uses overlapping regions to get response
  - Debevec & Malik invented basic technique, though we use method of Mitsunaga & Nayar
- The trick is image registration (alignment)
- Options to reduce lens flare & ghosting

# LDR Exposure Registration

The *median threshold bitmap* (MTB) allows us to quickly compare and align different images, because it is constant with respect to exposure for any camera with a monotonic response function

The same is not true for an edge map, which changes with exposure even with careful normalization and approximate response curves



# Image Pyramid Alignment



Grayscale images are scaled down repeatedly to create an image pyramid, which is then converted into MTBs for comparison

The smallest images are aligned first within a  $\pm 1$  pixel distance, which corresponds to a  $\pm 32$  pixel distance in the original

This becomes the MSB in the offset, which is shifted and used as the starting point for the next higher resolution alignment, and so on to the top

# Alignment Results



5 unaligned exposures

Close-up detail

MTB alignment

Time: About 1 second/exposure for 3 MPixel image

## Lens Flare Reduction



Before

After

## Ghost Removal



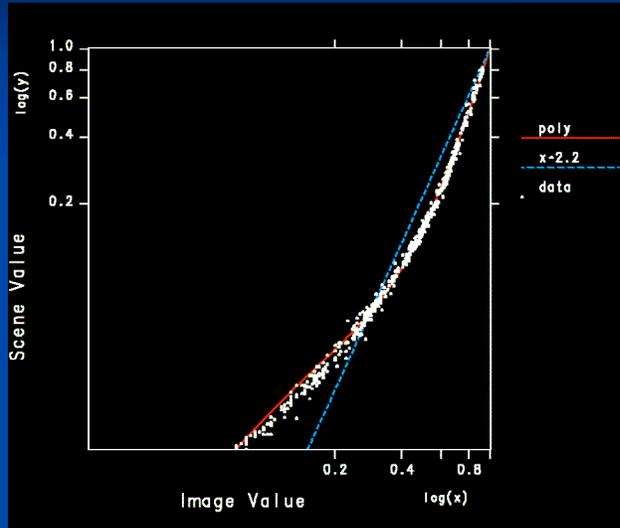
Before

After

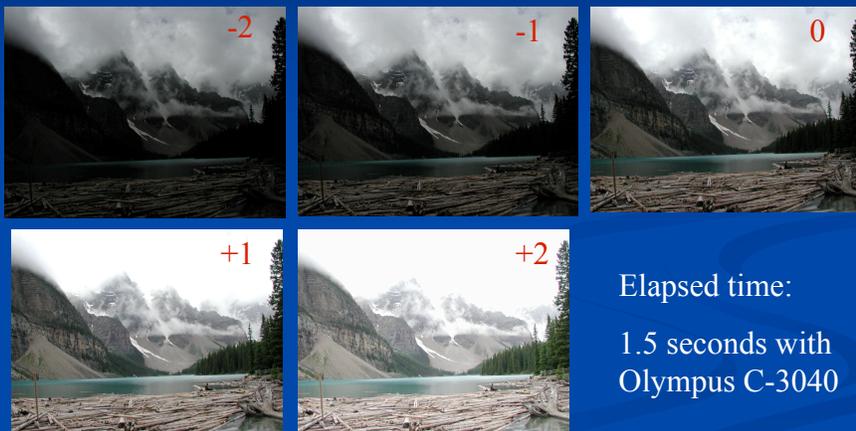
# Camera Response Recovery

Overlapping exposures allow us to extract the camera response function based on multiple measures of the same samples in a suitable static scene

A low-order polynomial is fit to the data, and the computed response function is stored for subsequent reuse on images taken with the same camera make and model

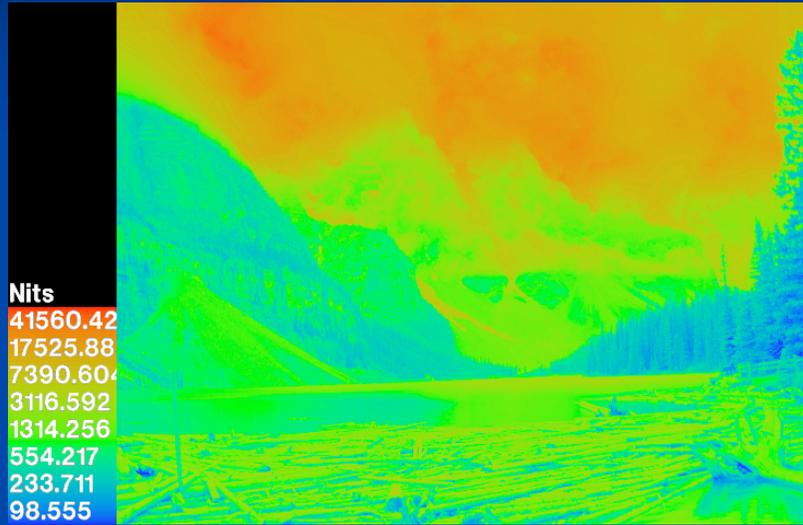


# Auto-bracket Exposures



Elapsed time:  
1.5 seconds with  
Olympus C-3040

## Combined HDR Image



## Tone-mapped Display

