Radiometric Calibration

CS635 Spring 2010

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Radiometric Calibration

- Since color is important, we want to emit and capture the colors we expect
- Example Goal:

  "Given a desired color **x**, instruct the projector to illuminate the color **y** such that what appears to the camera is **x**"

  …Ideally **x**=**y**, but in practice this is not the case

Radiometric Calibration

- Coordinate the per-channel color intensities between multiple projectors

Before light hits the image plane:

Scene → Scene Radiance L → Lens → Image Irradiance E

~Linear Mapping

After light hits the image plane:

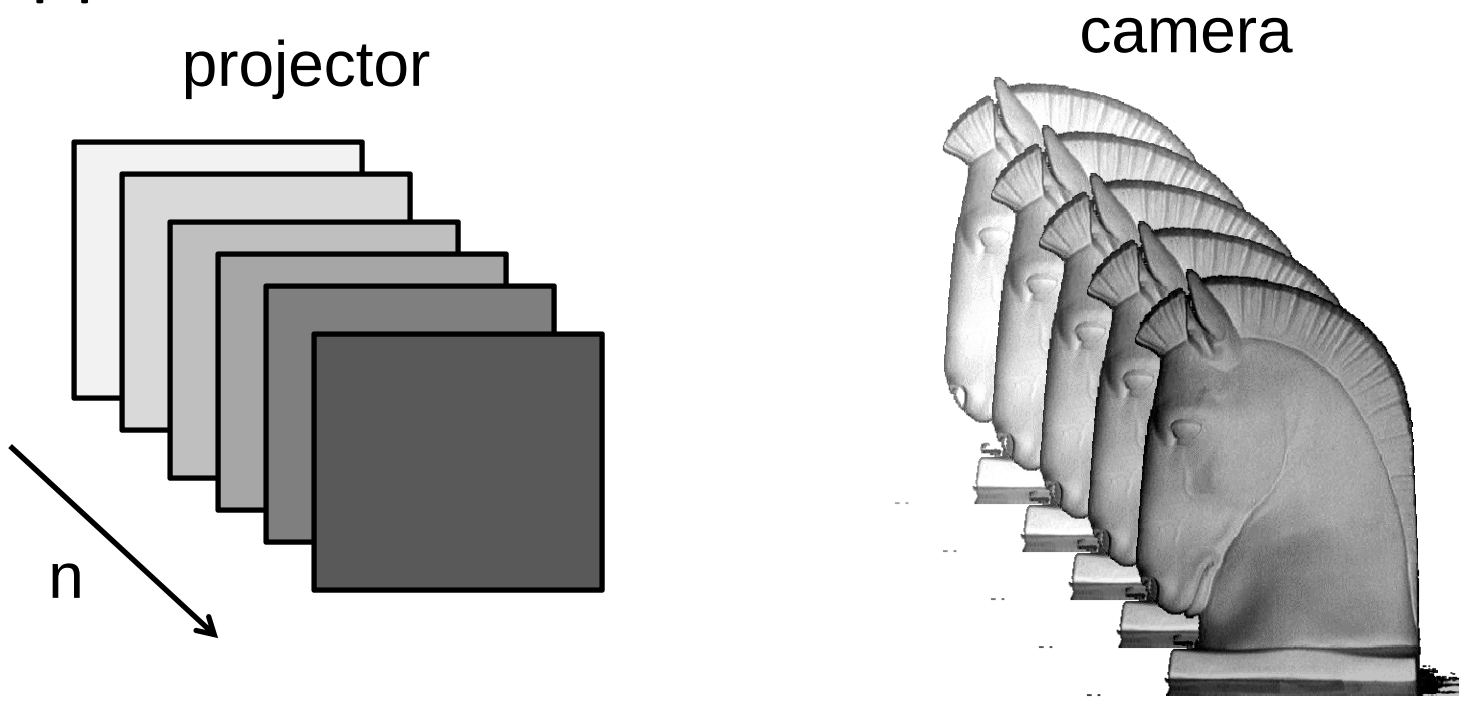
Image Irradiance E → Camera Electronics → Measured Pixel Values I

Non-linear Mapping

Can we go from measured pixel value, I, to scene radiance, L?

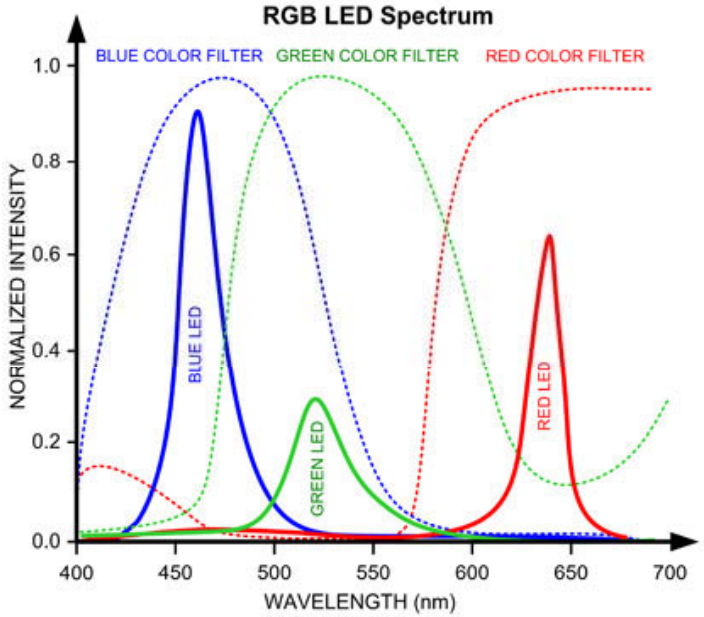
Grayscale Calibration

- Assuming n-bit channels, project 2^n “gray-level images” onto the scene and capture the appearance 2^n times



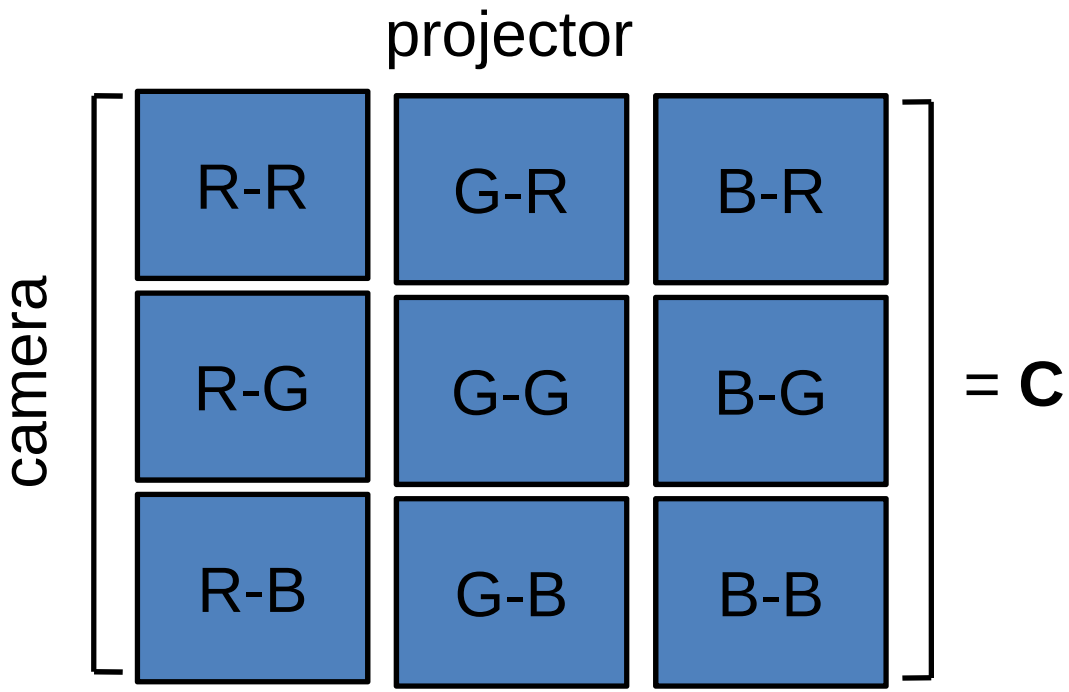
Going to Color

- When extending to color, since color channels are not fully non-overlapping, the color mixture must be taken into account



Color Calibration

- Assuming n-bit RGB channels, project 3 x 2^n "single-color images" onto the scene and capture the appearance 3 x 2^n times



Color Calibration

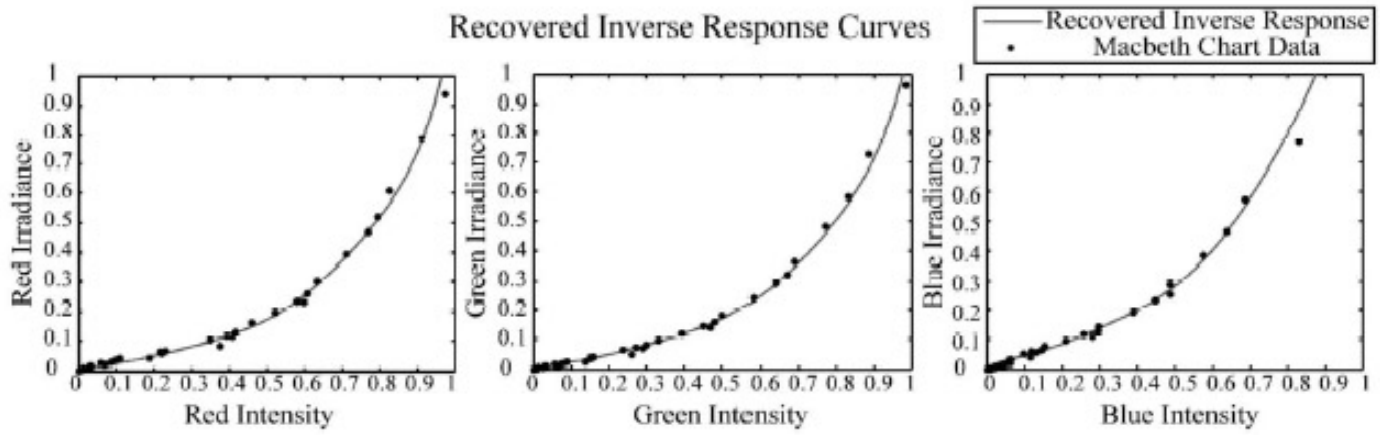
- **C** is the color mixture matrix
- **x** = projector color, **y** = camera color, thus

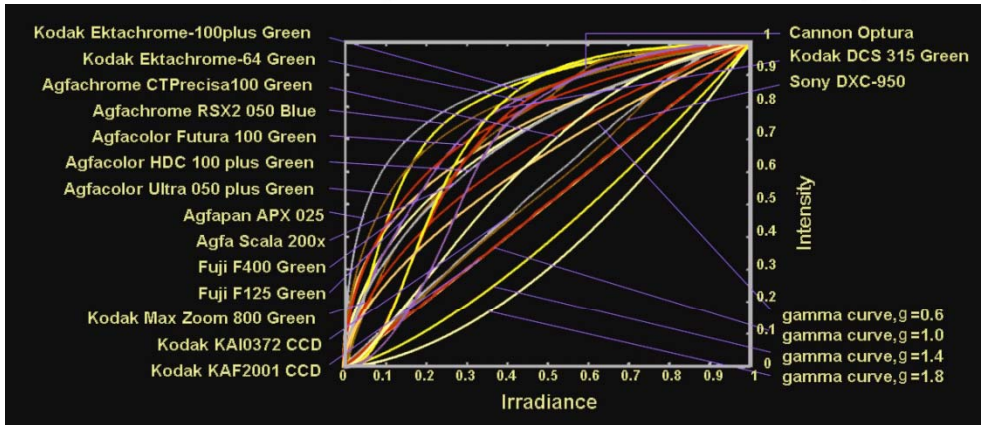
$$\mathbf{y} = \mathbf{C}\mathbf{x}$$

$$\mathbf{x} = \mathbf{C}^{-1}\mathbf{y}$$

Additional Issues

- Linear vs. Nonlinear Response





Nayar et al., CAVE

Additional Issues

- Exposure settings

  At what aperture and shutter speed?

  …behavior is not necessarily linear

  …can fix the settings but that obtains a limited dynamic range

- Vignetting

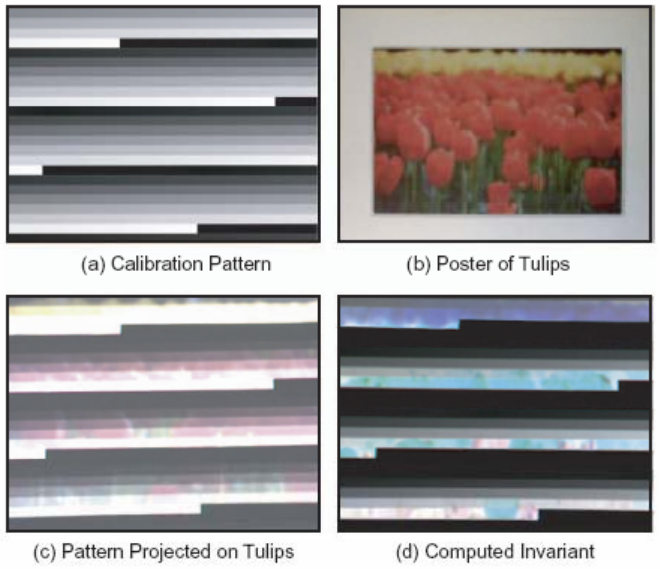
Reducing Acquisition Time

- For 8-bit per channel, RGB, multiple exposures (e.g., 3), means 256x3x3 = 6912 images

Acceleration schemes:

e.g., total of 6 images

"Making One Object Look Like Another"
Grossberg et al., 2004



Does not handle "inter-reflections"…