Horiuchi – Hirai Laboratory @ Chiba University

Special Topic: Multi-spectral Image Projector and its Applications

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CHIBA UNIVERSITY
堀内・平井研究室
Horiuchi – Hirai Laboratory

Brief Introduction of Our Lab.

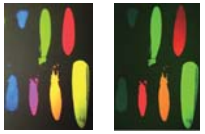
Image acquisition, analysis, processing, rendering and evaluation based on color, SHITSUKAN and vision engineering

< Multispectral Imaging >

- Digital archiving of oil paintings
- Spectral reflectance analysis of watercolors
- Real-time spectral relighting system
- Gigapixel spectral imaging system for omnidirectional scene archiving
- Estimating lighting environments under multiple illuminants
- Analysis of fluorescent objects
- Material classification for metal and dielectric objects

etc.

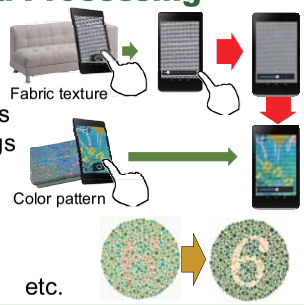

Rendering of oil art paintings under various illuminants


Object including fluorescent and extracted fluorescent components

< Image Analysis and Processing >

- SHITSUKAN image retrieval
- HDR video processing
- Tone reproduction of HDR images
- Color texture analysis of art paintings
- Image feature transfer of art paintings
- Interactive texture and color control of fabric images
- Canceling display surface reflection for smart-phones
- Color correction for color deficiency

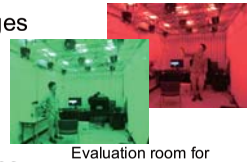
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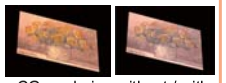


< Image Reproduction and Evaluation>

- Perceptual analysis of SHITSUKAN images
- SHITSUKAN analysis of line drawing
- Development of color adaptation models under various illuminant conditions
- Image evaluation of various projectors
- Evaluation of tone reproduction techniques using actual experimental scenes
- Perceptual analysis of fluorescent objects and its application to CG rendering
- Color harmony under various conditions

etc.


Evaluation room for various illuminant conditions


CG rendering without / with visual adaptation model

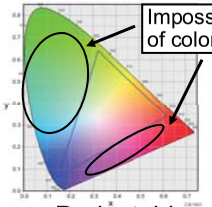
Special Topic: Multi-spectral Image Projector

From psychophysically-based trichromatic image display to physically-based spectral image display

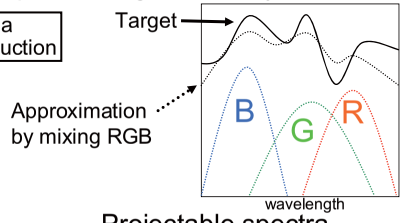
1. Background and Purpose

< Limitations of conventional RGB projectors>

1. Impossible to reproduce wide-gamut image
2. Impossible to reproduce spectral image accurately



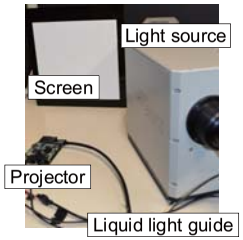
Projectable gamut



Projectable spectra

< Purpose > Developing Multi-spectral image projector

2. System Configuration







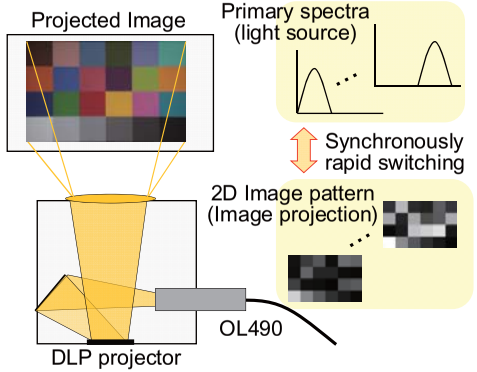
Light Source

- Programmable spectral light source (Optronic Laboratories OL490)
- 380 – 780nm
- Intensity: 0 ~ 100%
- Switching in 80μ sec.

Image Projection

- DLP projector (TI. DLP LightCrafter)
- Projection speed: 120 frames per seconds when using 8-bit image

3. Image Projection Principle

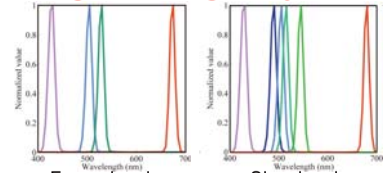


Typical examples of our projector specifications

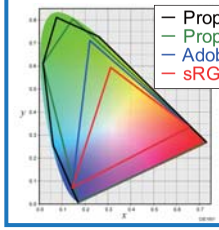
Image bit depth	Number of primaries	FPS
1	1	4000
1	20	200
4	1	360
6	1	240
8	1	120
8	4	30
8	6	20

4. Wide Gamut / Spectral Image Projection

Wide-gamut Image Projection


Four primaries

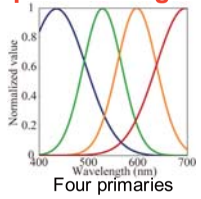
Six primaries

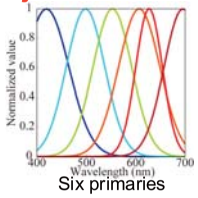


< Area ratio (normalized) >

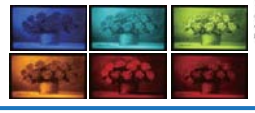
Proposed (six)	: 1.000
Proposed (four)	: 0.914
Adobe RGB	: 0.499
sRGB	: 0.362

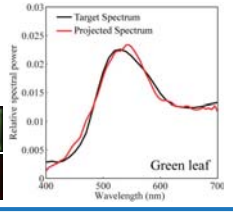
Spectral Image Projection


Four primaries


Six primaries

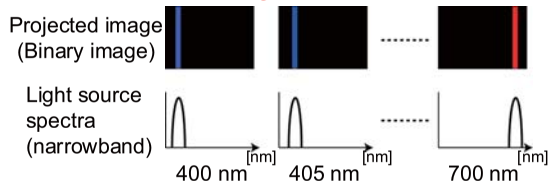


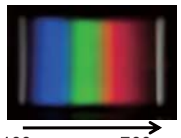




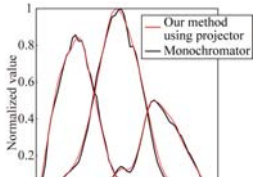
5. Other Applications (as a research platform for image, color and vision engineering)

Camera Sensitivity Measurement





Captured Image

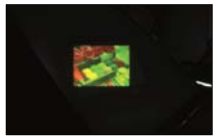


Geometric Calibration

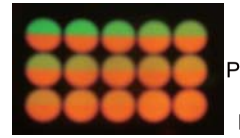
Projected image rectangularization using invisible (IR) projection


RGB projection (Captured by RGB camera)

Invisible projection (captured by IR camera)


Geometrically-calibrated RGB projection (Calibration based on the IR pattern)

Color Deficiency Test


Projected test pattern

- Same as the methodology based on anomaloscope
- Upper side: mixture of 545 nm green light and 665 nm red light
  Bottom side: 590 nm monochromatic yellow light
- Conducted by finding distinguishable circles
- **Simple and effective test**

(References) K. Hirai, D. Irie and T. Horiuchi, "Photometric and Geometric Measurements based on Multi-primary Image Projector," Proc. CVCS2015. (Patents) Japanese patent application No.2014-018081, No.2014-054238