Hybrid System for Correcting Non-uniformity in Viewing Booth for the Photographic-Arts and Printing Industry

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international circle of educational institutes for graphic arts: technology and management

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Outline

- Background
- Soft Proofing
- Typical and proposed soft proofing
- Viewing booth lighting
- Illumination Issues
- LCD Projector for Compensation
  - Methodology
  - Results
- Spectral Light Assessment
- Conclusion

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Proofing

- Proofing is a simulation of the printing press.
  - Hard-Copy Proof
  - Soft-Copy Proof

Printing Press

Soft proofing example

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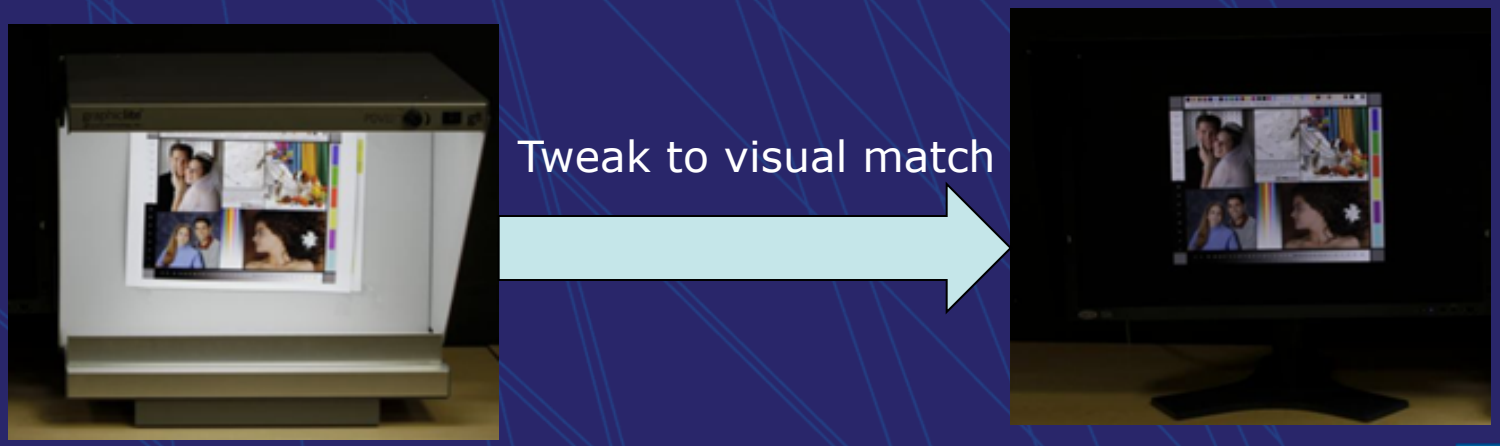
Typical Soft Proofing Model

- ICC profile is used
  - based on ideal D50 not the same in booth
  - Practical viewing conditions does not meet icc conditions
- Viewing booth
  - Not uniformly lit
  - Tweaking the intensity



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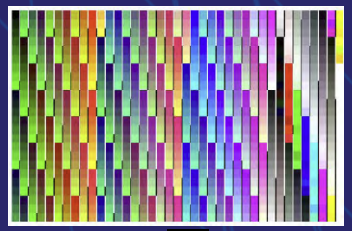
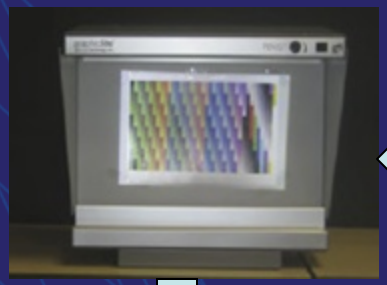
The Proposed Soft Proofing System





LCD Projector

Camera
(HDR capture)

ANN Training

Soft Proofing Model

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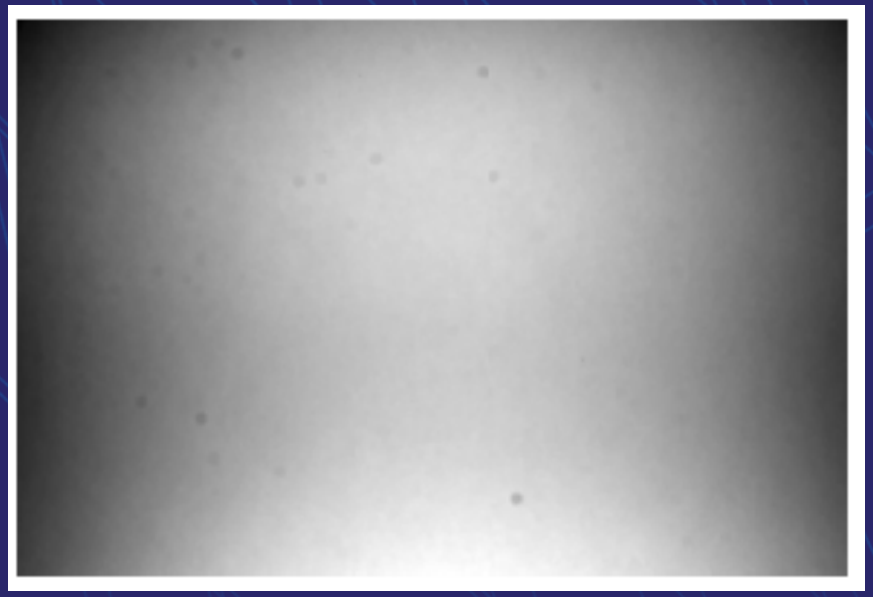
Viewing Booth Lighting

- The luminance was also measured using HDR for the same ROI
- It is very obvious that the booth is not uniform
- Method for compensating is needed



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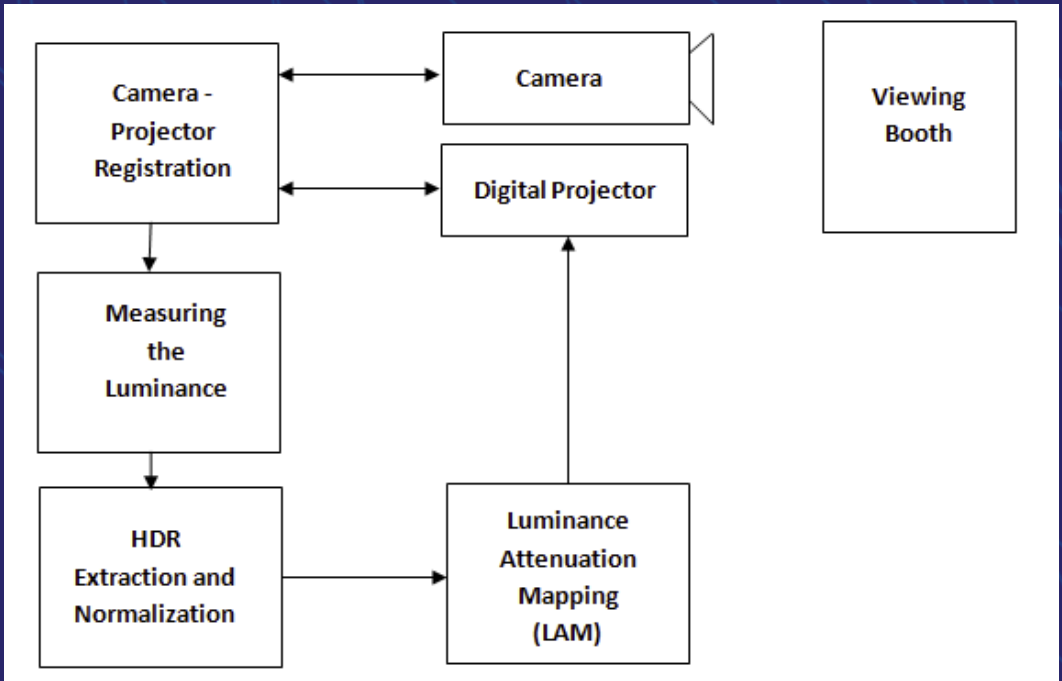
Uniform Viewing Booth Based on an LCD Projector (Patent Pending)



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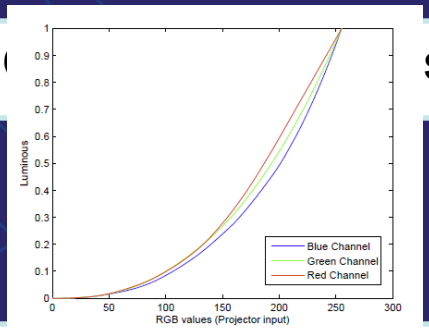
Hybrid Viewing Booth

Booth is (splays full black

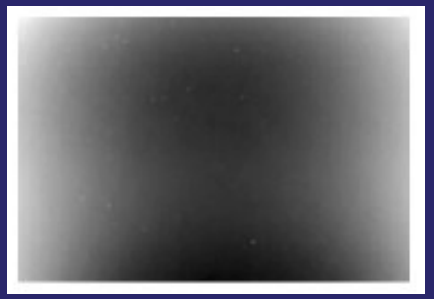


Registering ROI

Case	Min	Max	Mean	Std
Before	0.56	0.73	0.67	0.04
After	0.66	0.73	0.71	0.01

Measuring the Luminous using HDR

$L_{proj}=1-L_{booth}$



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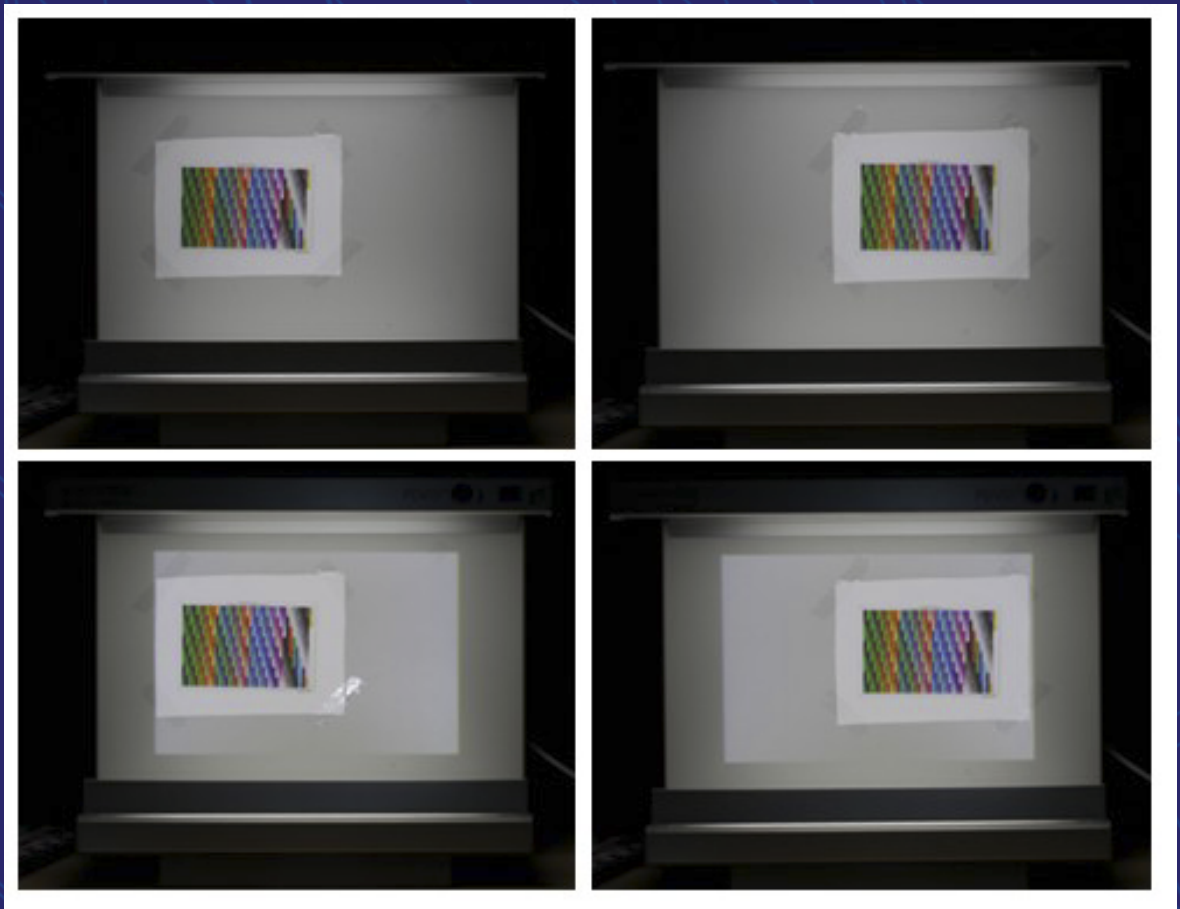
Testing



MSE_{RGB}=26.3

MSE_{RGB}=5.2

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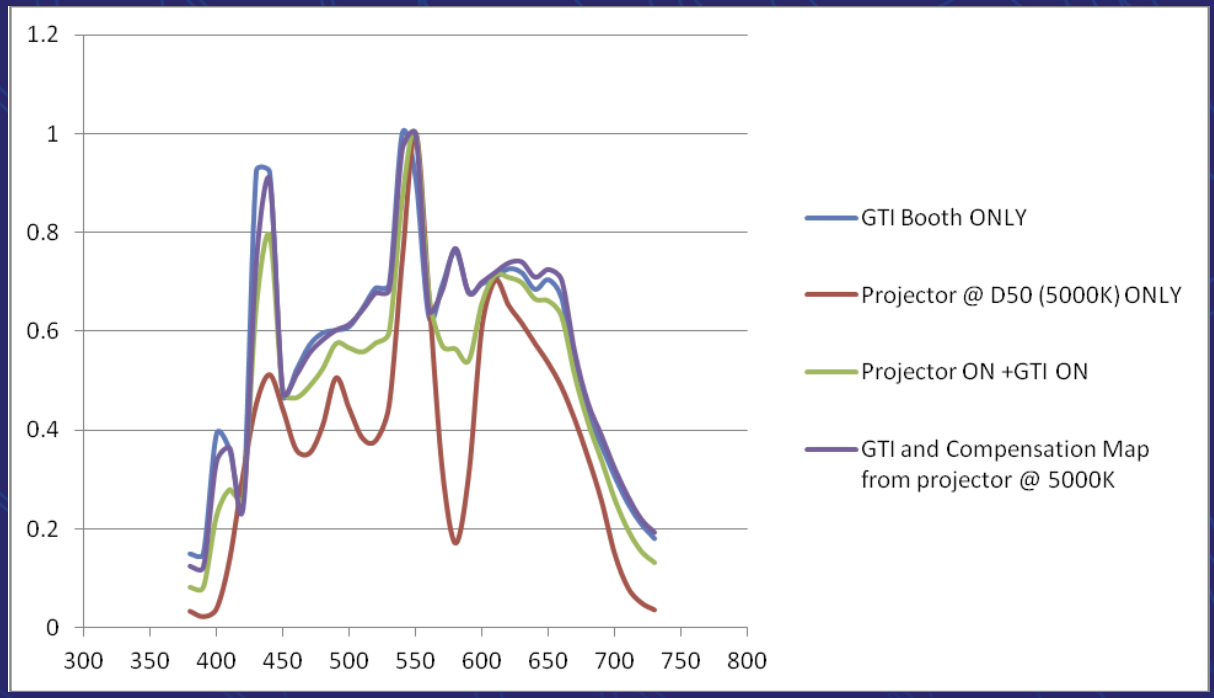
Spectral Light Assessment

- Further testing has been done to determine the resulting spectral lighting compared with D50 lighting

- Uniformity measures were tested before and after the compensation according to the ISO requirements



EVS2028 Viewing Booth by GTI

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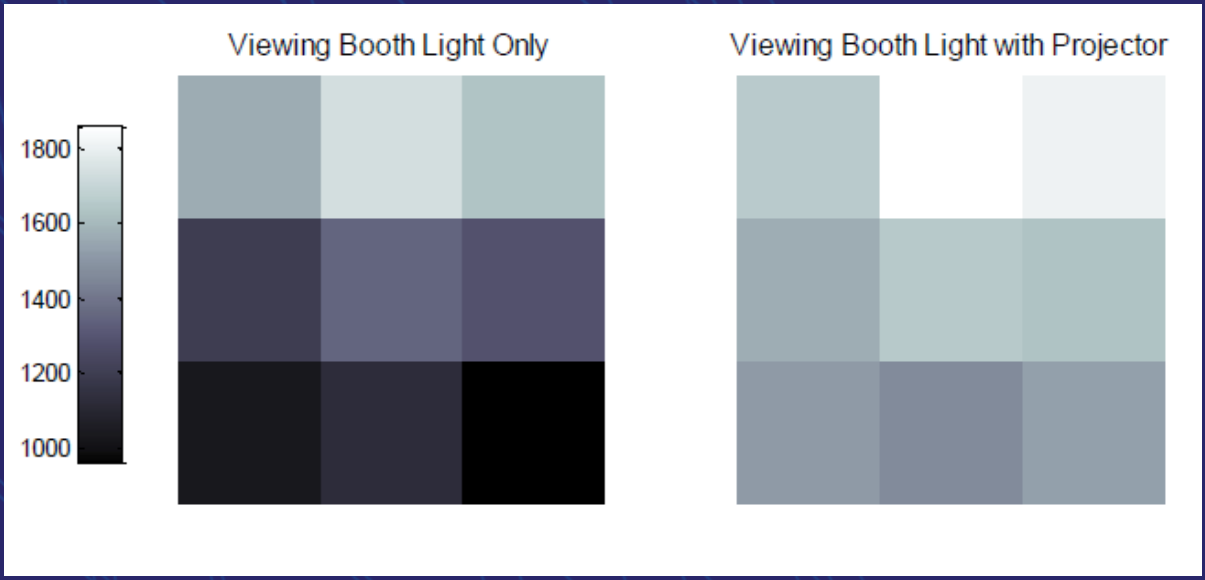
Conclusions

- A novel method for viewing booth light compensation
- The LAM for projector based on the spatial intensity of the white surface provides better uniformity compared with using green channel to create the LAM



Intensity in Lux on the viewing surface with and without compensation.

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Acknowledgment

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Thank you

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EVS2028 Viewing Booth by GTI

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Future Work

- Towards custom illuminants for proofing
  - GUI was created to allow the user to select any color from RGB sliders and produce a uniform illumination.

- Embedding Intensity changes within the proof
- Other Extensions and Practical Improvements
  - Camera Calibration
  - Mobile viewing booth
  - Tone compression techniques such as iCAM06
  - This system can be treated as scanner
  - LCOS projection technology instead of LCD

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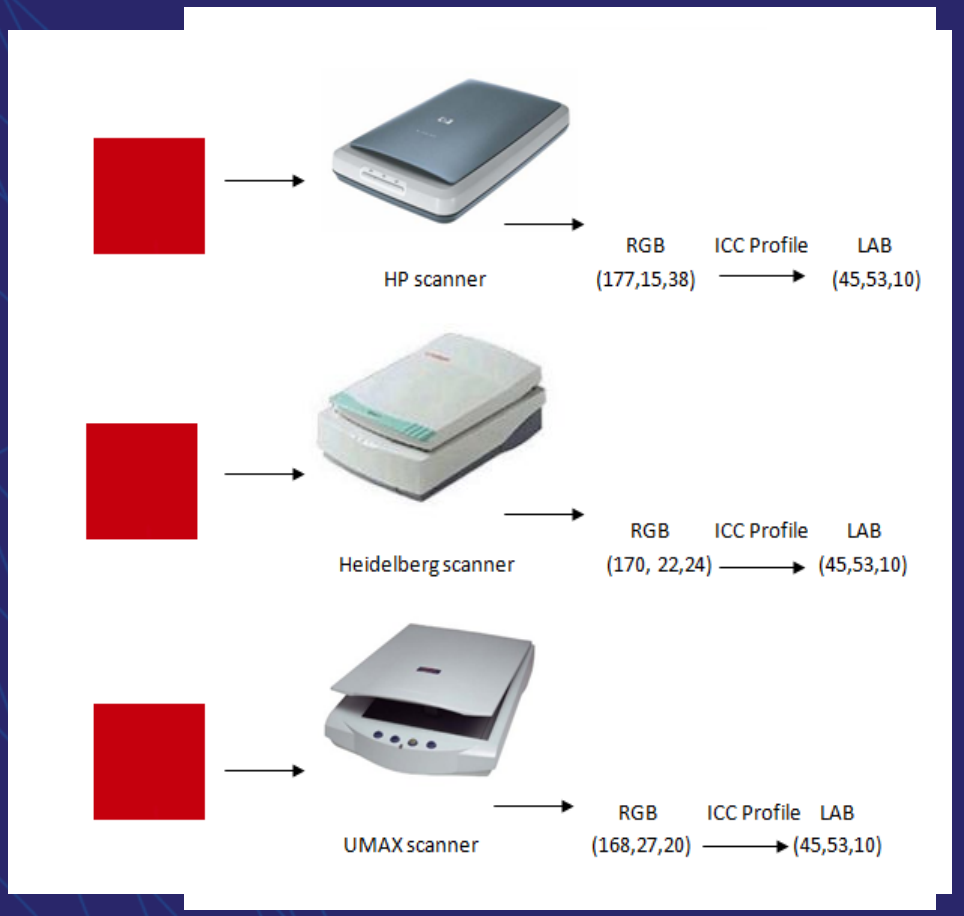
Color Management Issue

- Device - Dependent Color
  - RGB
  - CMYK
- Device - Independent Color
  - RGB and CMYK not reliable to communicate
  - Mostly used CIELAB
- Framework for PCS By International Color Consortium (ICC)
- Main Concept
  - Uses Look UP table
  - Non linear relationship
  - Bidirectional



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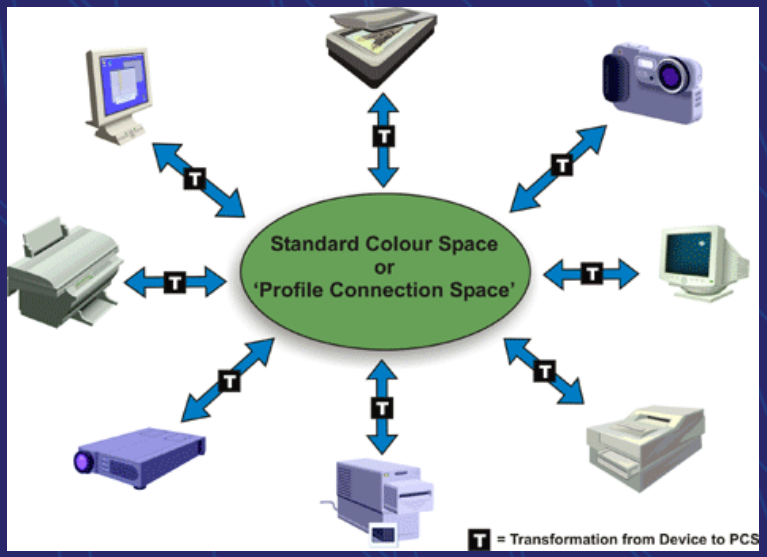
Device Characterization

- How to obtain an ICC profile
- Open-Loop Color Control
  - Measuring instrument
  - n devices, n connections
  - ProfileMaker Pro 5.0.8
  - One new device, one connection
  - Test chart



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Investigation of HDR for Soft Proofing

- Normal LDR imaging
  - Canon Rebel t1i 500D DSLR settings
  - ISO =100
  - Aperture set at 4.0
  - Shutter speed=1/30
  - A custom ICC profile was made

Original image

LDR image using custom ICC

ISO=200,A=4.0, Sh=1/10

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HDR Imaging Techniques

- HDR image shows the details with greater dynamic range
- Colors should appear more indicative of the original scene
- HDR with custom ICC was not a good match

Original image

HDR captured (printed)

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Building the model

- Since HDR gave a good match
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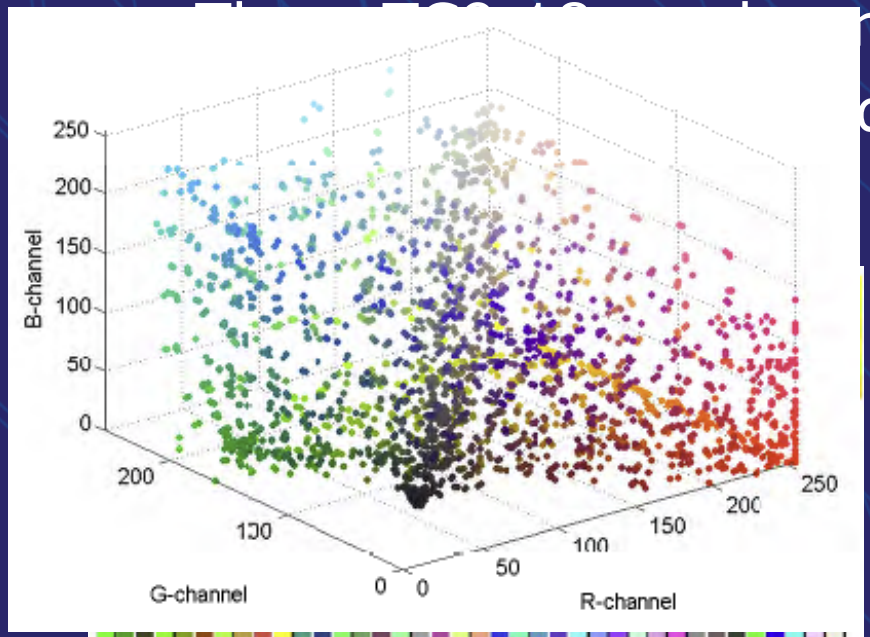
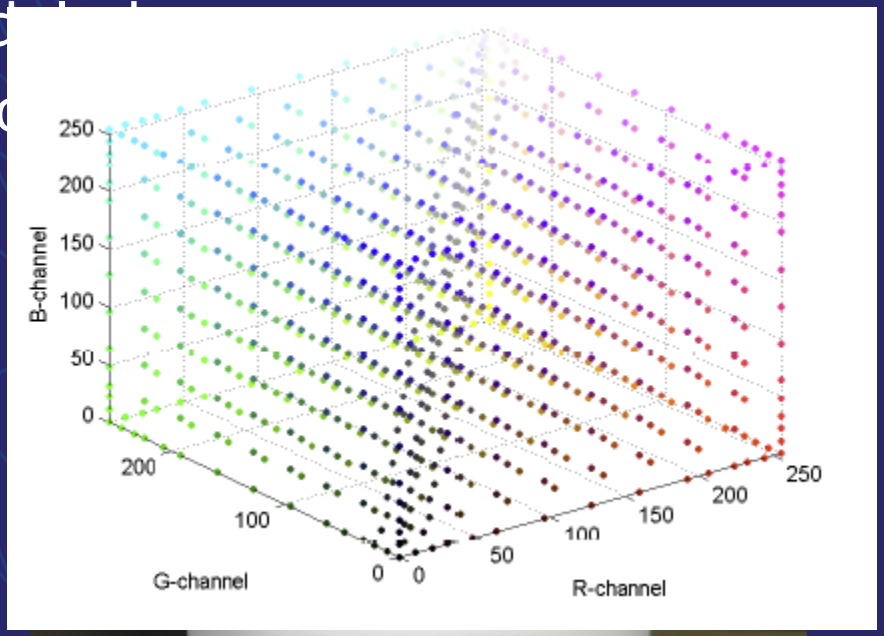
  [illegible]d fo[illegible]



RGB of Test Chart (Printed)

Test chart (Digital)



Original RGB of Test Chart (Digital)

Test chart in the booth (Printed)

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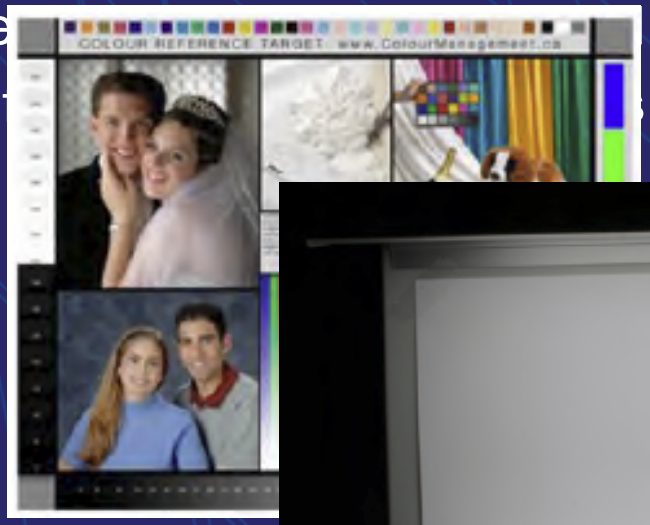
Training the model

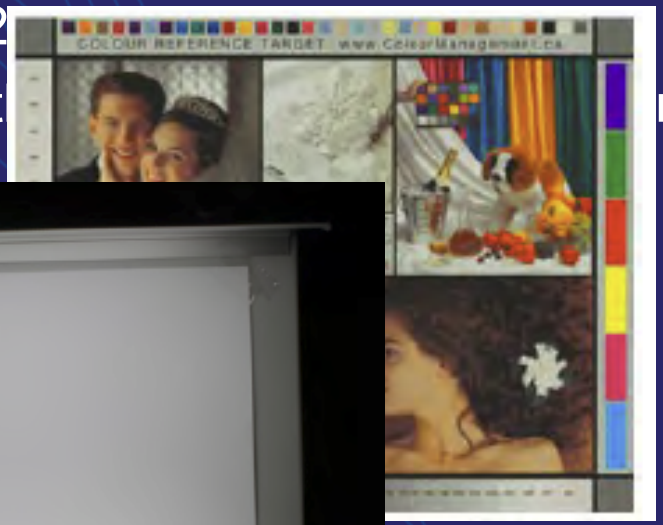
- ANN based LM algorithm
  - 2983 data points, each RGB has few printed RGB
  - 299 samples indexed at 1, 11, 21, 31, ...2981
  - 299 samples indexed at 2, 12, 22,32,.....2982

Hidden layer	MSE (Testing data)	Length (seconds)
360	4.8	135
600	4.5	533

Results

- Model was not accurate due to non uniform in the illumination
- A green patch has RGB of (52,123,65) at pos1 whereas same patch has an RGB of (61,141,70) at pos2
- The
- Uni





Original im

Printed)

Viewing booth lighting
with white paper

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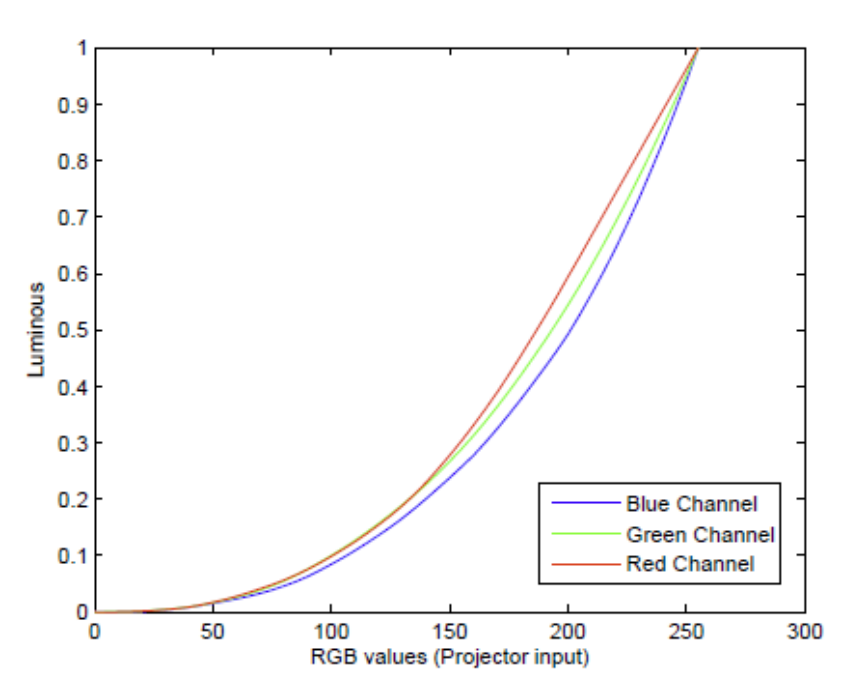
Calculating the Intensity Transfer Function of the Projector

- ITF was calculated for each channel as
  - 52 levels in step of 5 from 0 to 255
  - Luminance calculated for each level using HDR
  - Window of 20x20 was cut in center then averaged



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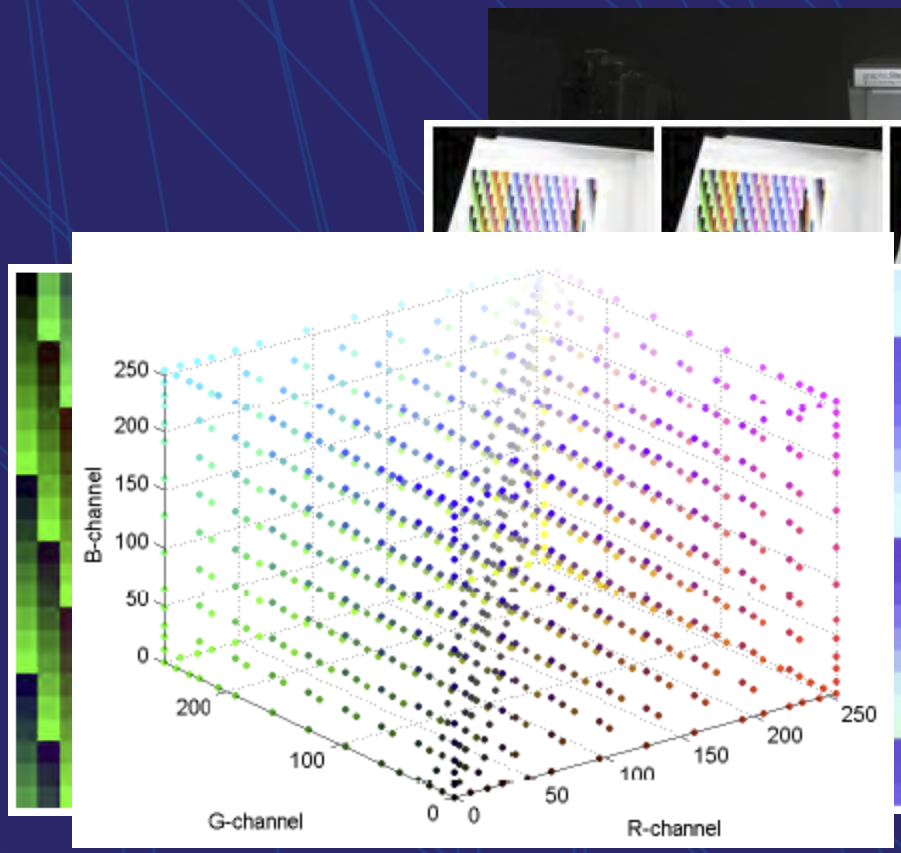
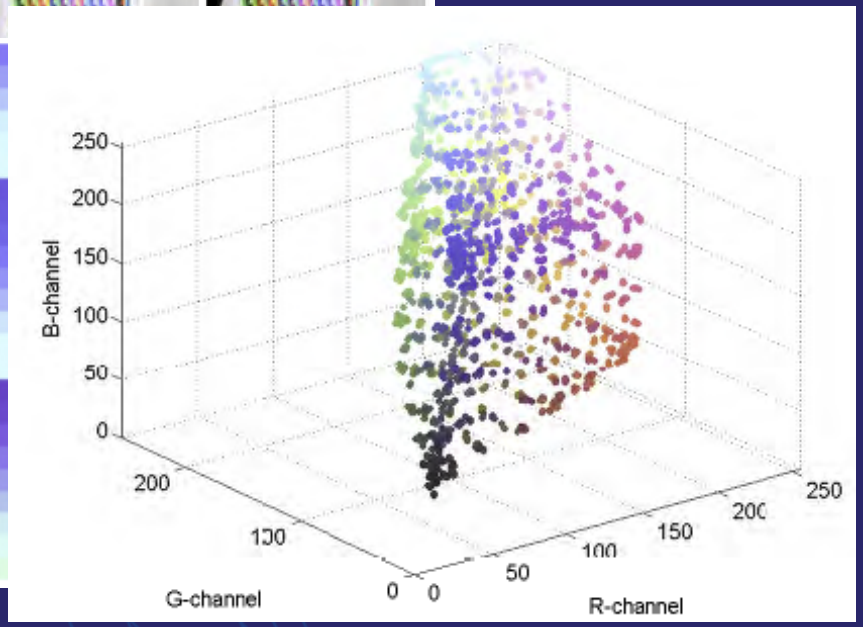
Soft Proofing Using Hybrid Viewing Booth



Original Digital RGB



RGB printed using the proposed method

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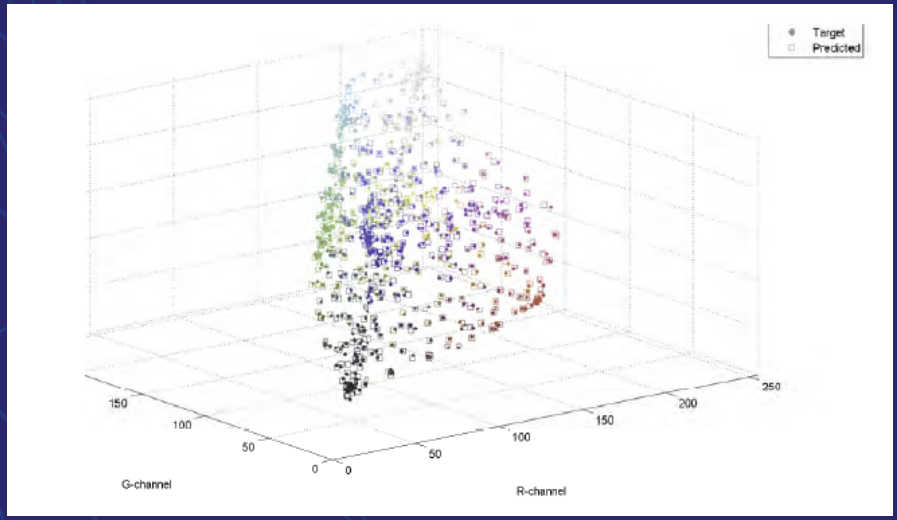
Training Process

- 911 unique samples (digital)
- 6531 printed samples
  - 5224 samples for training
  - 653 for validation
  - 653 for testing
- Training time 132 seconds
- MSE (testing)=0.008



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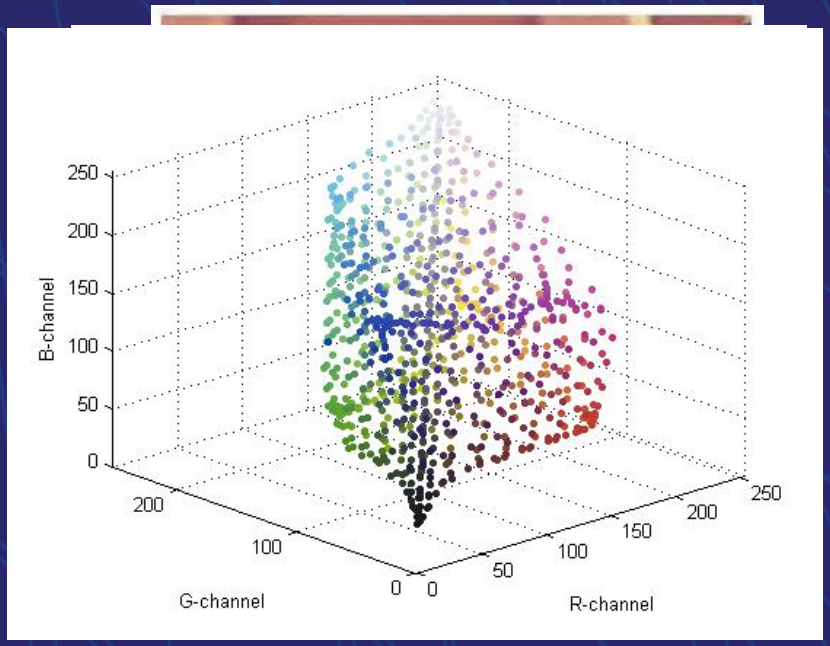
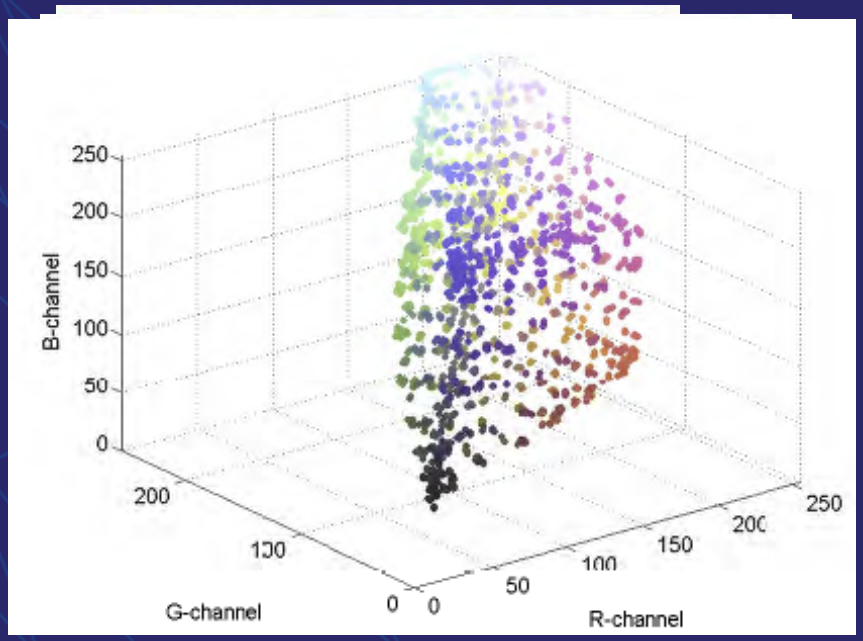
Results



Original image (Digital) RGB printed using ICC



Predicted image (Printed) RGB printed using the proposed method

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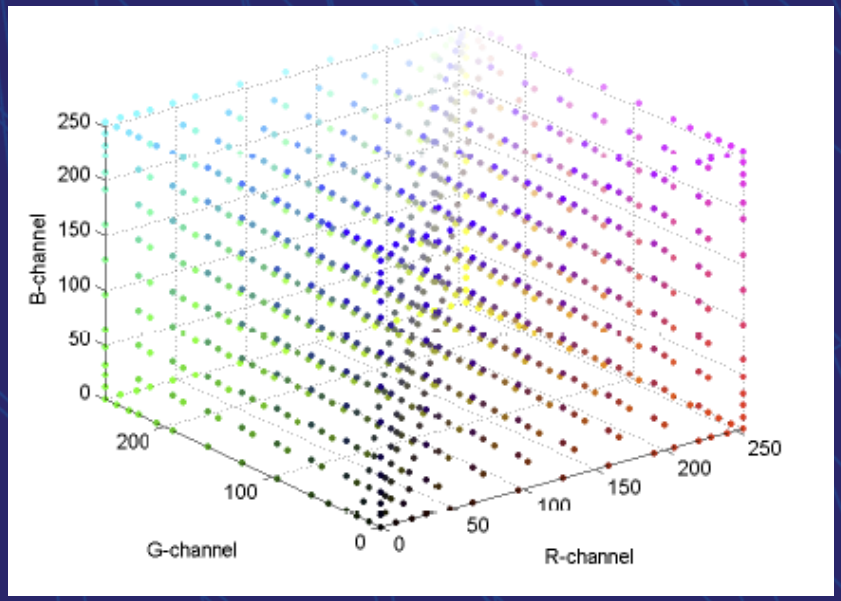
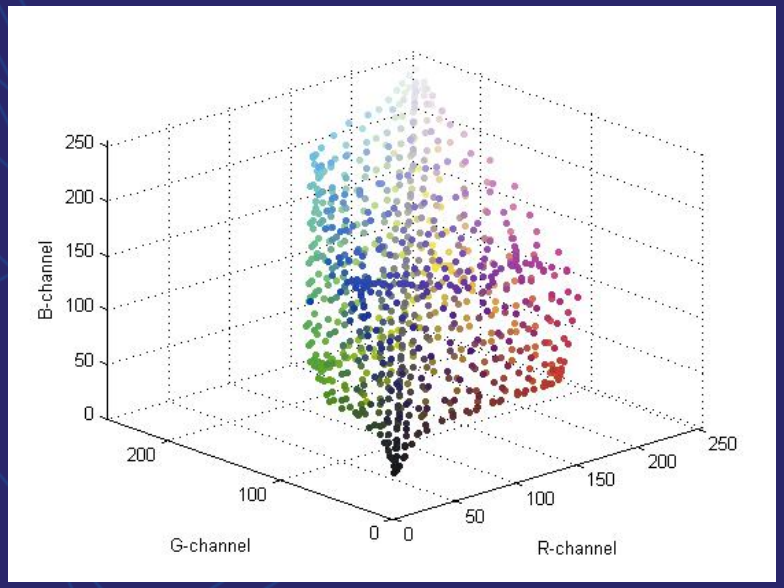
Typical Soft Proofing Model (Cont’d)



Original RGB



RGB printed using ICC

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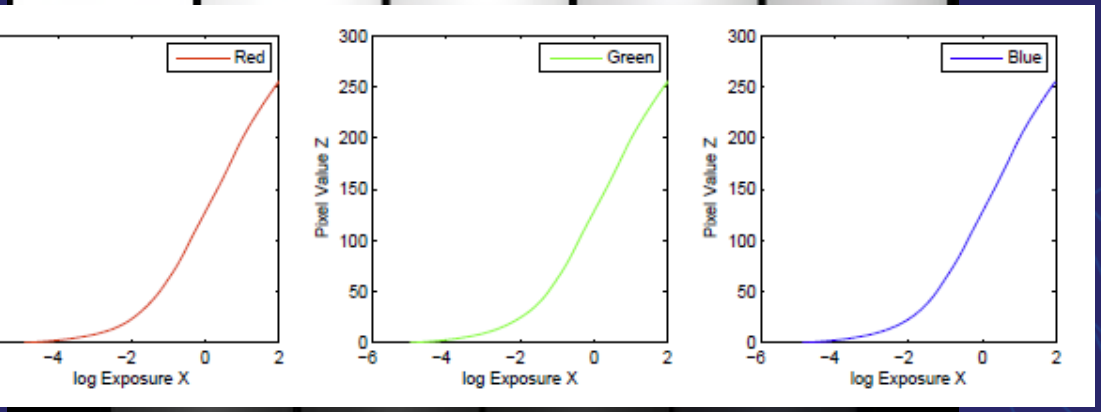
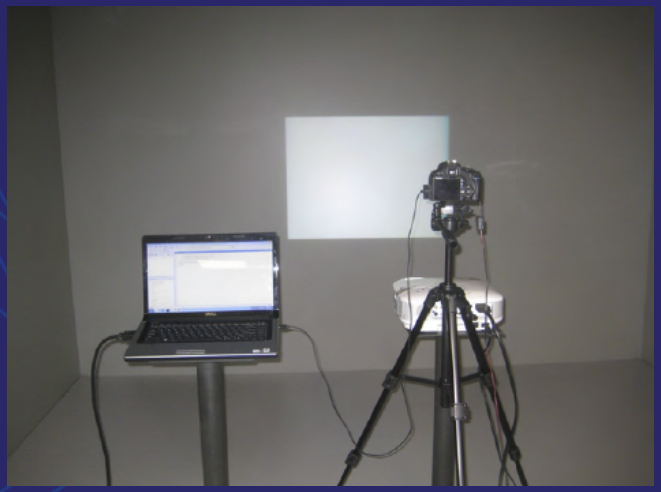
Viewing Booth Light Compensation

- Camera is used to measure Luminous
- Finding the Camera Response Curve (CRC)
- ISO = 100, AP = 29 → Neutral exposure is 1.3
- 19 differently exposed images
- 10 second to 1/6 second





Experimental Setup

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Uniform Viewing Booth Based on an LCD Projector

Case	Min	Max	Mean	Std	Std Norm
Before	147	162	157	2.2	0.008
After	143	150	147	0.78	0.003

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Calculating the Luminosity surface of the Projector

- Achieving Photometric Uniformity
- Luminance Attenuation Map (LAM)

Case	Max	Min	Mean	Std
Before	0.8	0.48	0.65	0.065
After using Green	0.77	0.71	0.74	0.0092
After using White	0.76	0.72	0.74	0.0066

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Hybrid Viewing Booth

Measuring the Luminous using HDR

Case	Min	Max	Mean	Std
Before	0.56	0.73	0.67	0.04
After	0.66	0.73	0.71	0.01

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