Developing a Peripheral Color Tolerance Model for Gaze-Contingent Rendering

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WHY
- Higher resolution
- Higher frame rate
- Immersive VR/AR

with WHAT
- Human peripheral vision property
- Eye tracking embedded headsets
- Gaze-contingent rendering

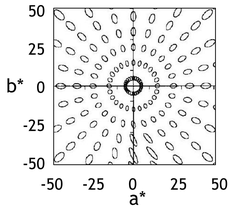
HOW
Peripheral color tolerance model

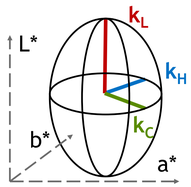
Model Peripheral Chromatic Discrimination

Describes small color difference

CIE DE2000

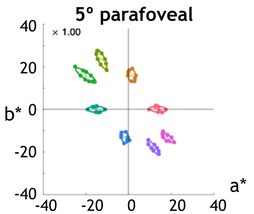
Standard color difference evaluation formula with adjustable parameters for viewing conditions.

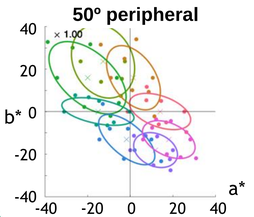




Eccentricity dependent

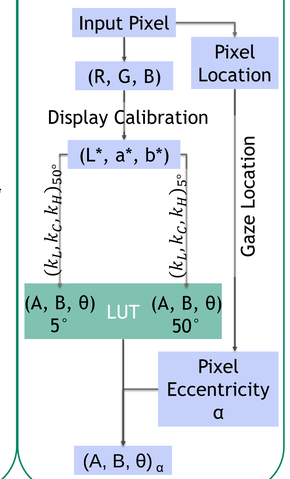
Measured chromatic discrimination contour at parafovea and periphery.





Runs in real time with eye tracking

Ellipse parameters stored as look-up-table to accelerate calculation.



Experiment 1: Discrimination Threshold

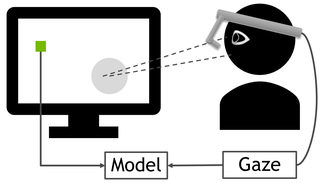
8K display & EyeLink II tracker

3 image types: simple / vector / natural

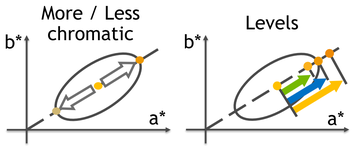
2 chromatic directions

10 levels (chroma vector length)

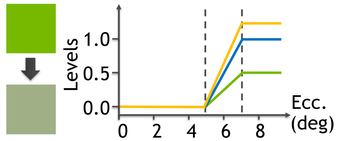
Question: Do you see foveation?



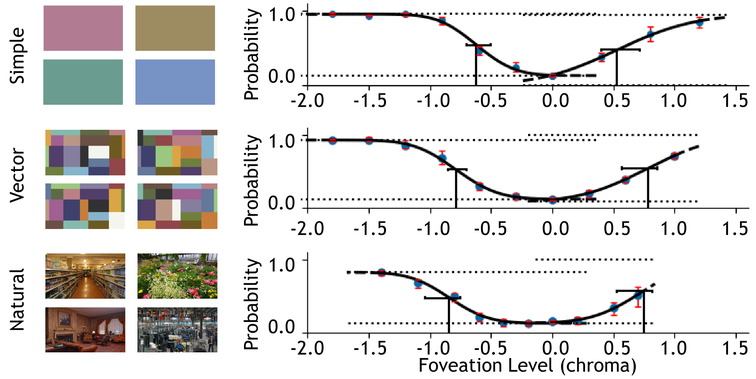
Simple image example



Natural image example



Result:
Model can be used in real time gaze-contingent rendering. The measured threshold slightly lower than model suggested. The threshold is content dependent



Experiment 2: Visual Difference Prediction

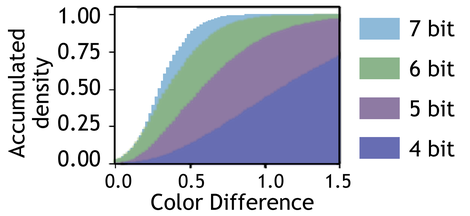
Same setup & question as Exp 1

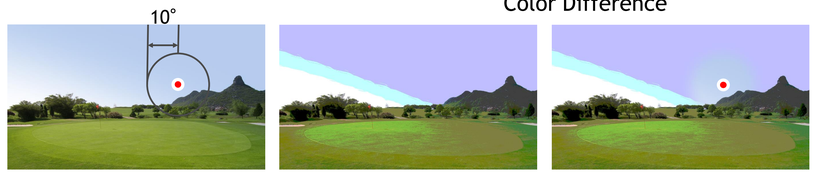
All natural images

Inside 10⁰ disk: original

Outside 10⁰ disk: modified

5⁰ - 10⁰ linear blending

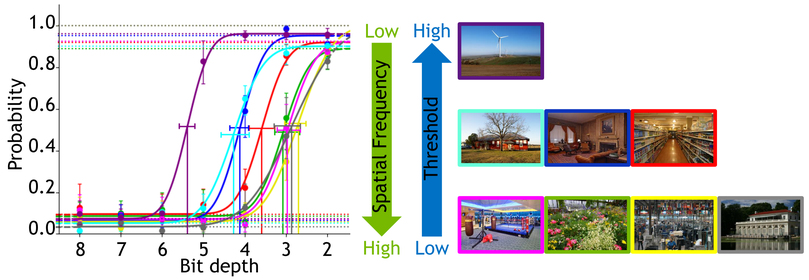




Original (8bit) Modified (3bit) Blended

Result:
- Small inter-subject variance but large inter-stimulus variance
- Threshold highly depends on image statistics

More chromatic discrimination data at different eccentricity would help interpolation. Image statistics (spatial filtering) should be included. Chromatic contrast and crowding effect should be considered.



Reference

Luo, M. R., Cui, G., & Rigg, B. (2001). The development of the CIE 2000 colour-difference formula: CIEDE2000. Color Research & Application, 26(5), 340-350.

Hansen, T., Pracejus, L., & Gegenfurtner, K. R. (2009). Color perception in the intermediate periphery of the visual field. Journal of Vision, 9(4), 26-26.

*Figures are adopted from the data reported in the paper

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