PEA-PODs: Perceptual Evaluation of Algorithms for Power Optimization in XR Displays

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Best Paper Award
Honorable Mention

SIGGRAPH 2024
DENVER+ 28 JUL — 1 AUG

Paper + Data + Code

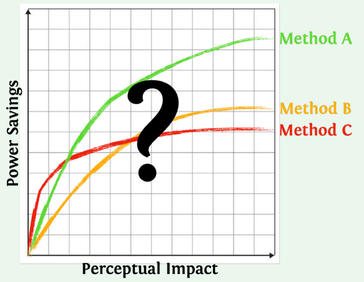
Problem

XR displays require *high*...

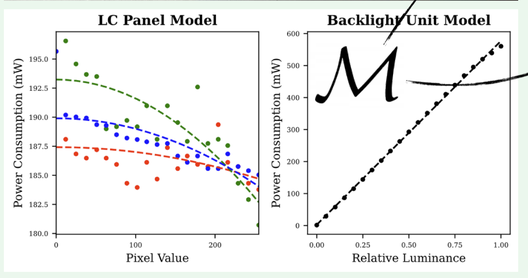
refresh rate, resolution, dynamic range, ...
which requires **high power consumption!**

Many proposals for display power optimization exist, but their measurements of perceptual impact were not standardized.

This makes it difficult to compare different algorithms in terms of **power savings** and **perceptual impact**.



Power Optimization in XR Displays



Global Dimming:

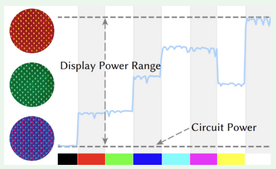
$$\mathcal{P}(\mathcal{I}) = \mathcal{M}(\max\{\mathbf{c} : \mathbf{c} \in \mathcal{I}\})$$

Local Dimming:

$$\mathcal{P}(\mathcal{I}) = \frac{1}{N}\sum_{i=1}^{N} \mathcal{M}(d_i)$$

OLED Display:

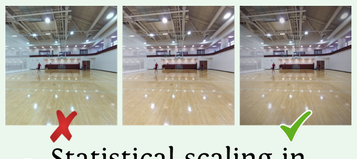
$$\mathcal{P}(\mathcal{I}) = \sum_{\mathbf{c}\in\mathcal{I}} \mathbf{p}^\intercal \mathbf{c}$$



[4]

Perceptual Evaluation of Algorithms

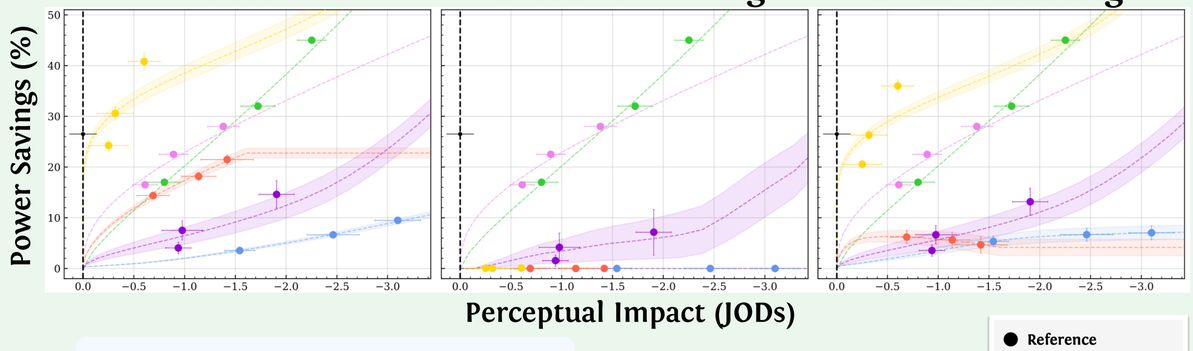
- Show users reference and 2 videos with power-saving algorithms applied,
- Ask users **"which video has higher quality?"**



- Statistical scaling in perceptual JOD unit.

Results

OLED · Global Dimming · Local Dimming

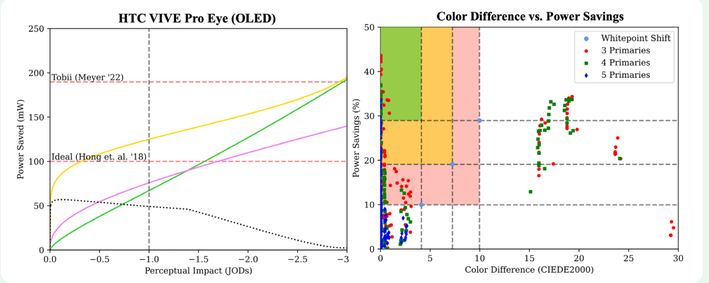


OLED › › › › › ›
Global › ›
Local › › › › › ›

Ranking @ 1 JOD

- Reference
- Uniform Dimming
- Luminance Clipping
- Brightness Rolloff
- Dichoptic Dimming
- Color Foveation
- Whitepoint Shift

Applications



Considering eye tracker power, brightness rolloff saves less power than uniform/dichoptic dimming.

Found primaries in multi-primary display which minimize color difference.

References

[1] *Brightness preservation for LCD backlight dimming*, Kerofsky & Daly, 2006

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[3] *Peripheral dimming: A new low-power technology for OLED display based on gaze tracking*, Kim & Lee, 2020

[4] *Color-Perception-Guided Display Power Reduction for Virtual Reality*, Duinkharjav & Chen et. al., 2022

[5] *FocusVR: Effective & usable VR display power management*, Wee et. al., 2018