elaTCSF: A Temporal Contrast Sensitivity Function for Flicker Detection and Modeling Variable Refresh Rate Flicker

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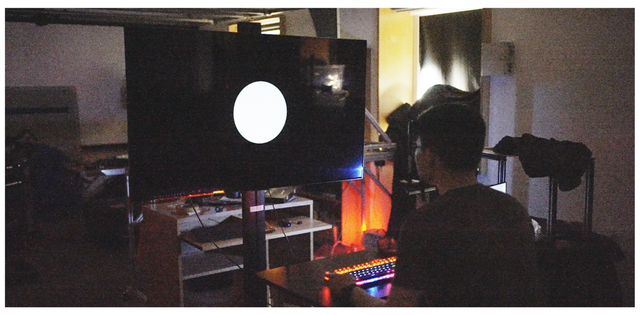

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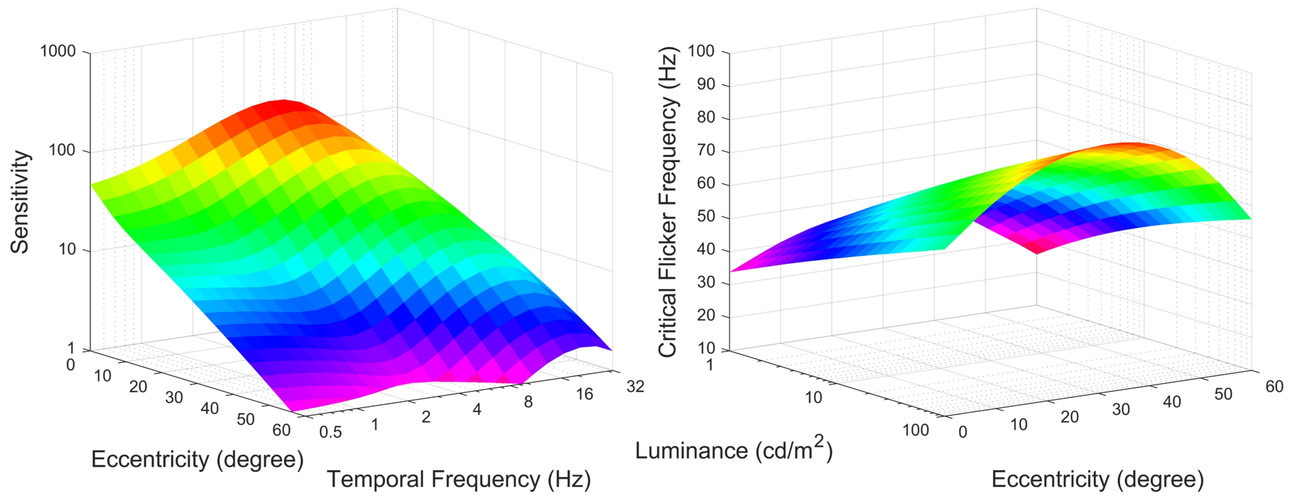
Project page



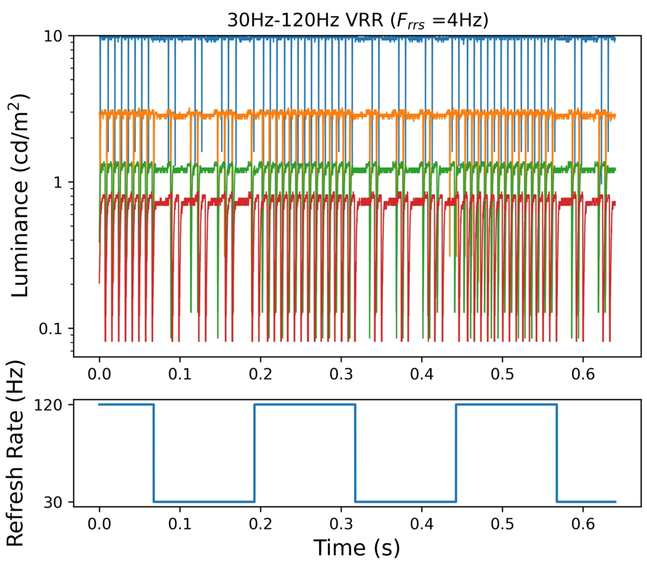
Motivation

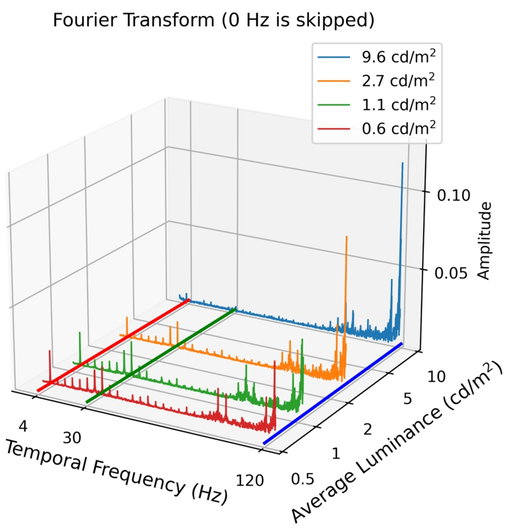
Variable Refresh Rate (**VRR**) flicker is increasingly common in advanced displays, yet research on VRR flicker detection and VRR datasets remains limited.

- The 2023 flicker detection standard $\mathbf{TCSF}_{IDMS}$ overlooks crucial parameters: luminance, eccentricity, and area. Another commonly used standard, CFF, is primarily suited for high-contrast flicker.
- A 120-year-long debate: Is flicker more visible in peripheral vision?
- How to analyze flicker stimuli over a very large visual field? (Single eccentricity is not applicable.)

VRR Flicker Sensitivity Experiment

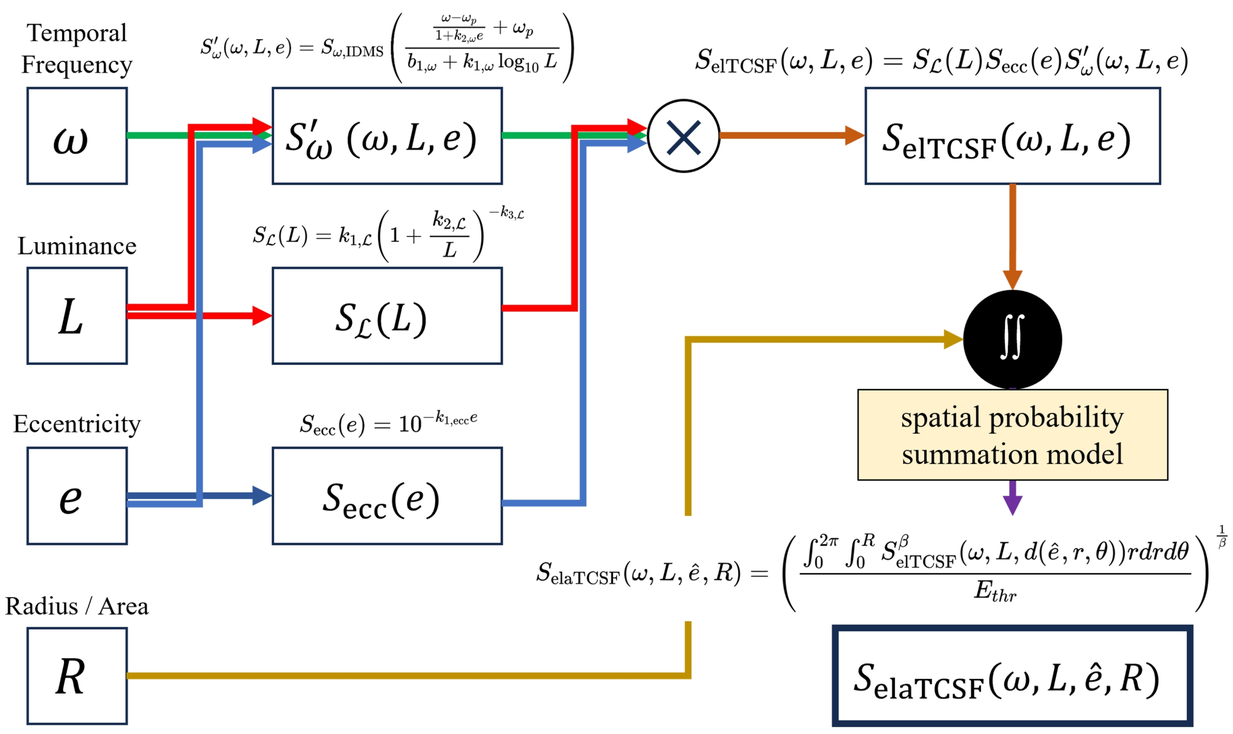
1. **Display Equipment:** LG OLED G1 55" 4K Smart TV
2. **VRR Flicker Stimuli:** discs of $0.5^\circ, 1^\circ, 16^\circ$ (diameter) + entire screen ($62.7^\circ \times 37.8^\circ$), black background. The refresh rate was switched between 30 and 120 Hz in a square-wave pattern. The frequency of refresh rate switch $F_{\mathrm{rrs}} =$ $0.5, 2, 4, 8, 10, 11.9, 13.3, 14.9$ Hz.





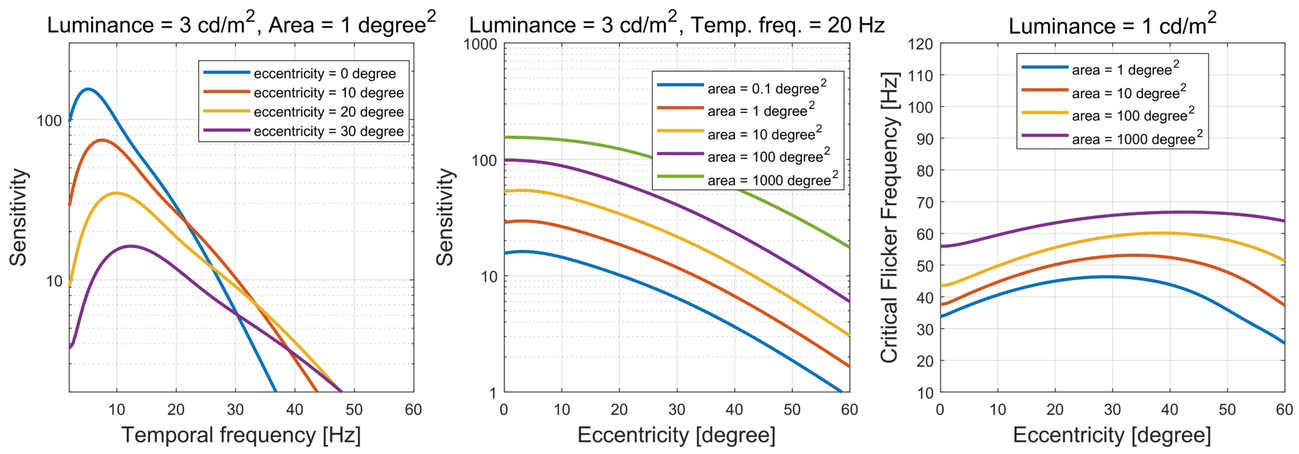
3. **Experimental Procedure:** 16 participants
   1. MOA (method-of-adjustment)
   2. QUEST – 2AFC (2-interval-forced-choice) – 40 trails
4. **Results (See the Model Fitting & Comparison Section →)**

elaTCSF Model



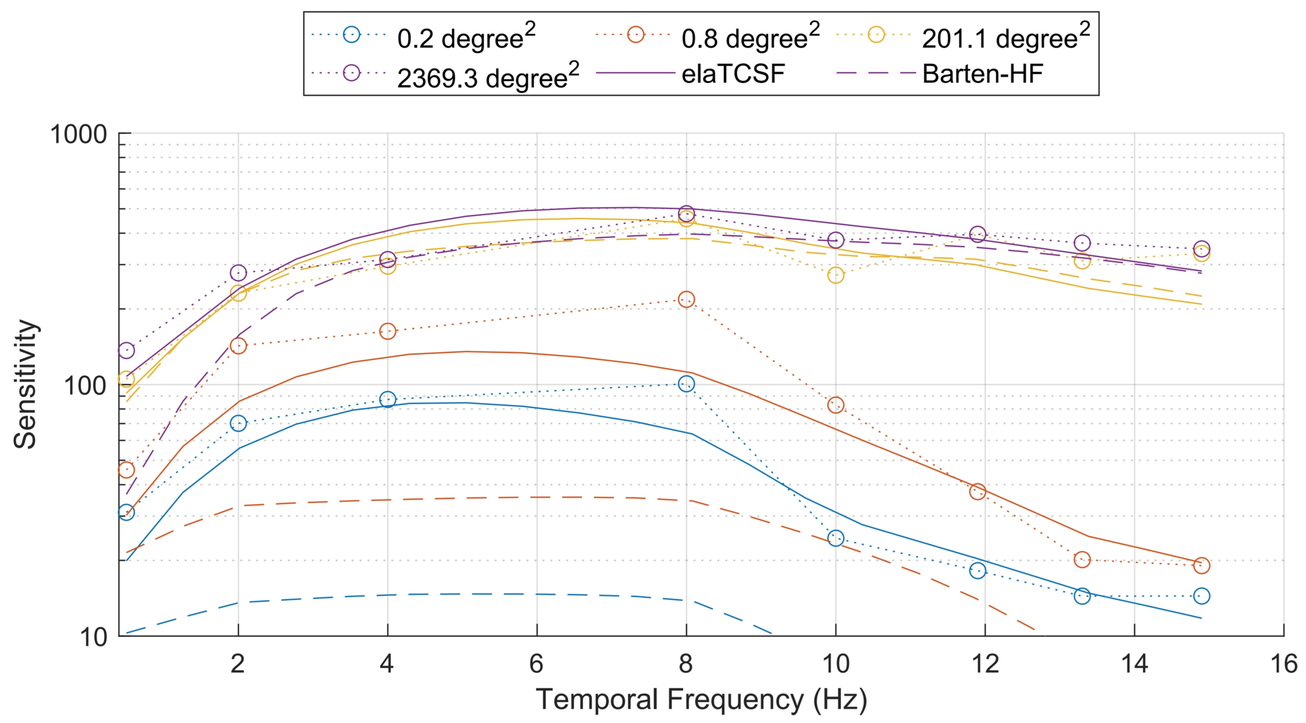
Parafovea Flicker Sensitivity

- The TCSF changes its shape with eccentricity — it becomes flatter (the slope decreases) as eccentricity increases.
- The CFF in the parafovea is higher than in the fovea, but the peak sensitivity in the parafovea is lower than in the fovea.



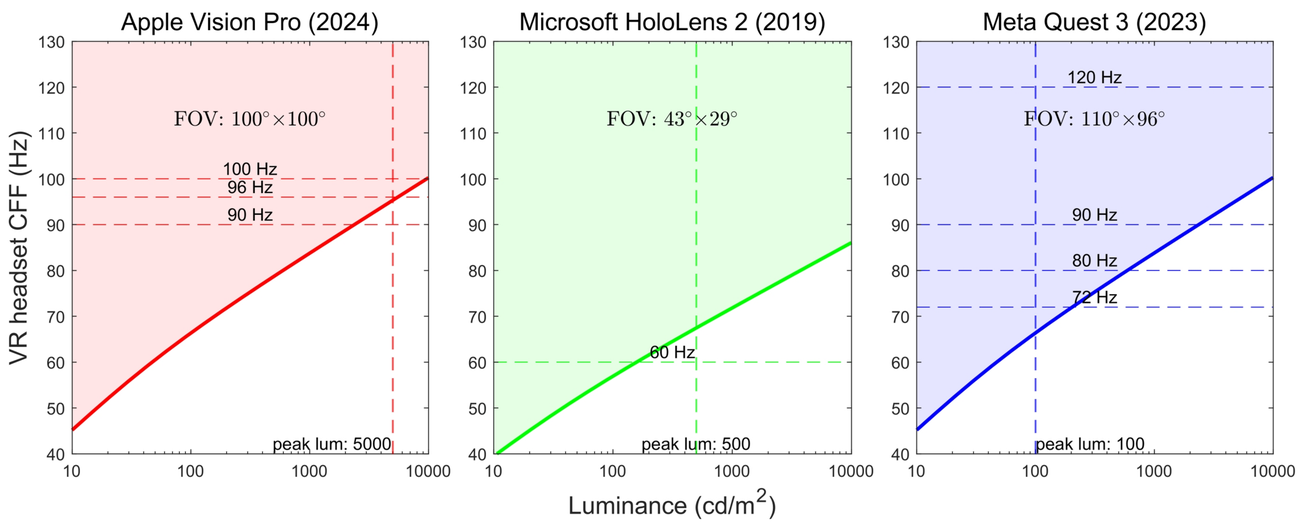
Model Fitting & Comparision

8 datasets were utilized for model fitting & comparision: [Hartmann 1979 CFF], [de Lange 1958 CFF], [Krajancich 2021 CFF], [Chapiro 2023 CFF], [de Lange 1958 Sensitivity], [Kelly 1961 Sensitivity], [Snowden 1995 Sensitivity], [Yancheng 2024 Sensitivity] (VRR Flicker - ours)



Applications

- **Prediction of Frame Rate Range for VRR Displays**
- **Low persistence flicker in VR headsets**



- **Application in lighting design**