Characterizing Phone Screens with Colorimetry

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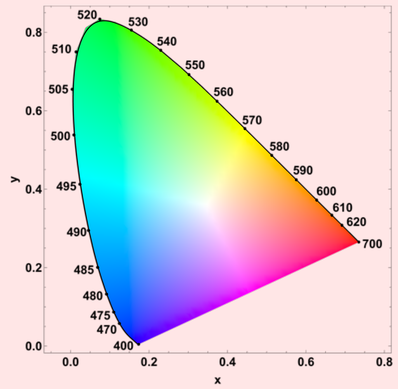
Introduction



- The chromaticity diagram is a representation of colors with the cartesian coordinate plane.

- We can take an emission spectrum and project it onto red, green, and blue basis functions via:

$$X_i = \int_{-\infty}^{\infty} \phi_i(\omega) S(\omega) d\omega$$

Where ϕ_i define red, green, and blue as functions as described by CIE 1931[2] and S(ω) is our spectrum.

- We can convert these into coordinates using:

$$x = \frac{X_1}{\|X\|_1}, \qquad y = \frac{X_2}{\|X\|_1}$$

- Lastly we can calculate how close a color is to monochromatic light, or purity as:

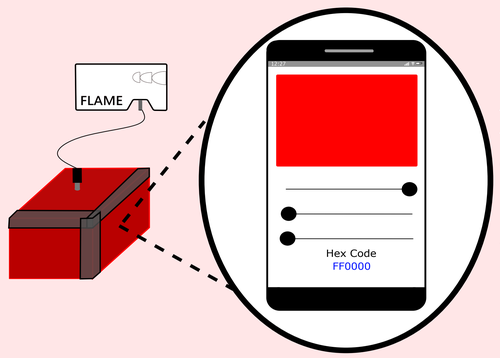
$$P(\vec{x}) = \frac{\|\vec{x} - \vec{w}\|_1}{\|\vec{x} - \vec{x}_{\text{mono}}\|_1}.$$

Where x is our color coordinate, w is the white point, and x_{mono} is the monochromatic point.

- Using the red, green, and blue color measurements, we can map out a devices entire range of color outputs.

- This is our other metric of phone preformance, as it describes the amount of colors that can be produced.

Methods



- Phones are placed inside of the box shown to the left.

- The Flame spectrometer is inserted through the top of the box.

- OceanView Software was used to record data. Data was imported into mathematica to be processed.

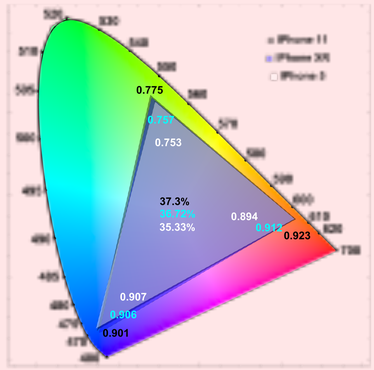
References

1. J. Schanda, “Cie colorimetry,” in Colorimetry (John Wiley Sons, Ltd, 2007) Chap. 3, pp. 25–78.

2. C. Wyman, P.-P. Sloan, and P. Shirley, Journal of Computer Graphics Techniques (JCGT) 2, 1 (2013).

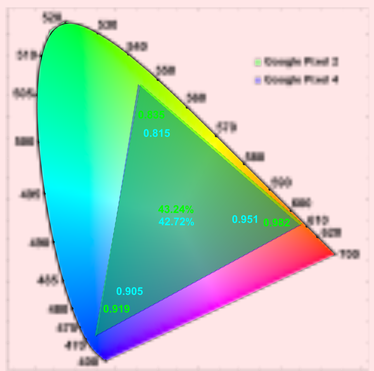
Results

iPhones



- iPhone devices have overlapping gamut coverages with slight variation.

Google Pixels



- Google Pixel devices also have overlapping gamut coverages with similar purities.

- There is little improvement among both brands of smartphone.

Conclusion

- There are no significant changes between the iPhone screens in the 7 years between the iPhone 5 and iPhone 11.

- With no implication of change, there is no incentive to upgrade phones for better visual quality