Review on one aspect of colour quality: visual appreciation

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Introduction

One important aspects of colour quality is the appreciative viewing of colour objects and in particular object found in real life (fruit and vegetables, skin complexion…). For the moment the only recommended and worldwide used metric is the Colour Rendering Index given by general and special indices. Nevertheless, CRI only considers the fidelity of object colours under the test light source in comparison with the same object colours under a reference light source. Over the past years, particularly since the emergence of Light Emitting Diodes, there has been increasing evidence that CRI fails to correspond to the overall perceived colour quality. That is why a new Technical Committee, TC 1-91 has been open to consider "New Methods for Evaluating the Colour Quality of White-Light Sources". This TC will evaluate all the dimensions of colour quality except fidelity. In my article I will consider one aspect of colour quality which is visual appreciation/colour preference. Evidence accumulated over the years show that objects colours often look better if the deviate from perfect colour fidelity and that certain shifts are preferred by observers. This idea is not new, Sanders [1] published in 1959 preferred chromaticites for a number of natural objects, in 1967 Pracejus [2] introduced the notion of Gamut Area and this idea was the basis of Judd's Flattering Index [3] and Thornton's Colour Preference Index [4] in the seventies. More recent research on colour memory suggests that object colours are often remembered more saturated that they really are [5]. Moreover the Memory Colour Rendering Index developed by Smet seems to be highly correlated to colour preference, suggesting that memory colour correspond to idealized object colour which is linked to preferred object colours that have higher chromatic saturation than they really have. In other words colour memory, colour preference, colour enhancement, visual appreciation seems to be linked.
In this article we want to investigate these aspects. In the first part, we will review the literature concerning the colour appreciation metrics, in the second part, we will present the results of 3 experiments lead in our laboratory and review other psychophysical studies in terms of appreciation. In a third part, we will discuss about the protocols, the semantic, the objects presented and the influence of other parameters. The article will not aim to analyze metrics performance but will try to underline important aspects of colour appreciation and how we could access them through visual judgment.

Metrics

This part will present metrics that include some preference aspects:

- Judd's Flattery Index [3]
- Thornton's Color Preference Index [4]
- Gamut Area based Indices [2] [6] [7] [8] [9]
- Feeling of Contrast Index [10,11]
- Colour Quality Scale (CQS,Qp, Qg) [12]
- Memory Colour Quality Metric [5]

Experiments

Experiments lead in our lab (Figure 1):

- simultaneous pair judgment of attractiveness for MacBeth ColourChecker [13],
- simultaneous pair judgment of attractiveness for fruit and vegetables [13, 14],
- successive scaling judgment for appreciation of face complexion [15].

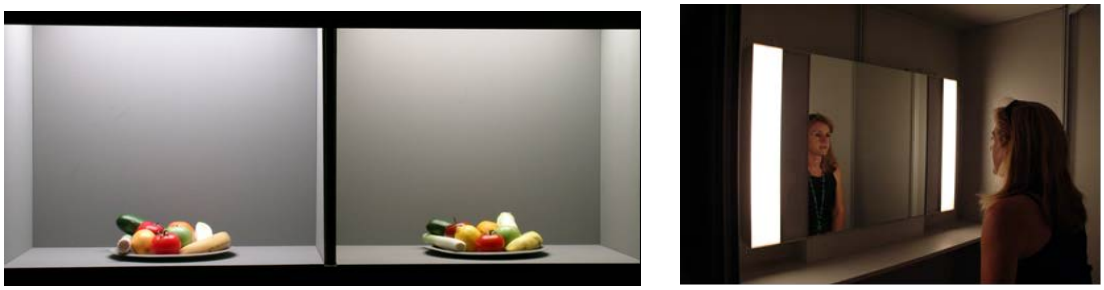

Figure 1. Experiments done in our Lab

Experiment lead by other teams: Smet [16], Narendran [17], Szabo [18], Imai [19] , Bodrogi [20].

Results

In the results part, we will investigate:

- Protocols used (viewing condition, pair comparison, successive,
- Scaling systems (forced choice, discrete/continuous scale…)
- Semantic of visual appreciation (preference, attractiveness, beauty…)
- Object presented (2D, 3D, real, photographic, natural, manufactured)
- Number of observers

In the results part we will also make the distinction between visual appreciation and colour enhancement because even if colour enhancement is appreciate, studies showed that increasing to much the chroma lead to unnatural colours which is rejected by observers.

References

1. Sanders, C. Color preferences for natural objects. Illum Eng, 1959; 54: 452-456
2. Pracejus, W. Preliminary report on a new approach to color acceptance studies. Illum Eng, 1967; 663
3. Judd, D. A Flattery Index For Artificial Illuminants. Illum Eng, 1967; 62: 593-598
4. Thornton, W. A validation of the color-preference index. Illum Eng, 1974; 4: 48-52
5. Smet, K.A., et al., Memory colours and colour quality evaluation of conventional and solid-state lamps. Opt. Express, 2010; 18(25): p. 26229-26244
6. Thornton, Color-discrimination index. J. Opt. Soc. Am., 1972; 62(2): 191-194
7. Fotios, S., The perception of light sources of different colour properties. UMIST 1997
8. Xu, H., Colour rendering capacity and luminous efficiency of a spectrum. Lighting Res Tech, 1993; 25: 131-131
9. Rea, M.S. and J.P. Freyssinier-Nova, Color Rendering: A Tale of Two Metrics. Color Res Appl 2008; 33(3): 192-202
10. Hashimoto, K. and Y. Nayatani, Visual clarity and feeling of contrast. Color Res Appl, 1994. 19(3):171-189.
11. Hashimoto, K., et al., A new method for specifying color rendering properties of light sources based on feeling of contrast. Color Res Appl, 2007; 32(5): 361-371
12. Davis, W. and Y. Ohno. Colour Quality Scale. Opt Eng 2010; 49(3)
13. Jost-Boissard, S et al. Colour rendering of LED sources: visual experiment on difference, fidelity and preference. In Light and Lighting Conference with Special Emphasis on LEDs and Solid State Lighting. Budapest; 2009
14. Jost-Boissard, S. and al, Perceived lighting quality of LED sources for the presentation of fruit and vegetables. J Mod Opt, 2009; 56(13): 1420-1432.
15. Jost-Boissard, S. and Fontoynont M, Colour rendering of face complexion and hair under LED sources. In proceedings of CIE Centenary Conference. Paris; 2012
16. Smet, K., and al., Correlation between color quality metric predictions and visual appreciation of light sources. Opt Express, 2011. 19(9): p. 8151-8166
17. Narendran, N., and al. characterizing white LEDs for general illumination applications. In Proceedings of SPIE. San Jose; 2000
18. Szabó, F., P. Csuti, and J. Schanda. Color preference under different illuminants—new approach of light source colour quality. In Light and Lighting Conference with Special Emphasis on LEDs and Solid State Lighting. Budapest; 2009
19. Imai,Y. and al, A study of color rendering properties based on color preference for LED lighting. . In proceedings of CIE Centenary Conference. Paris; 2012
20. Bodrogi, P., et al., Visual assessment of light source color quality. Color Res Appl, 2013. 38(1): p. 4-13

Author Biography

Sophie JOST received her MS in Civil Engineering from INSA de Lyon (2006) and her PhD in Building Science specialty in Lighting from ENTPE (2010). Since then she has worked in the Civil Engineering and Building Laboratory at ENTPE in Lyon, France. Her work has focused on Light sources quality assessment and on visual characterization and optimization of SSL. She is on the Board of CIE France and member of TC1.90 and TC1.91.