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EXPLORING THE USE OF CIECAM02 FOR PREVENTIVE CONSERVATION ISSUES

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Introduction

«Preservation Target» (PT) is a key concept in preventive conservation: it delimits the conditions that will optimize the value of a collection (or individual item) in a specific timeframe. In regard to lighting PT is often expressed in terms of maximum color change tolerated per century on the item on display. **But what is color change?**

While it is well known that color change can be measured without being perceptible, figure 1 highlights that color change can also be perceived without being measurable. **The relevant color change to define PT is the one affecting the item perception rather than the one instrumentally measured**. Therefore how well the numerical color change is connected to the induced change in the perception of the item is sensitive to the definition of PT.

Color Appearance Model (CAM) provides mathematical formulae to transform physical measurements of stimulus and viewing environment into correlates of perceptual attributes of color. This paper proposes exploring how the field of conservation would benefit from using the **CIECAM02** through two preventive conservation related applications.

Exploring the use of CIECAM02 for Preventive Conservation Issues

Color Appearance Model (CAM) are developed in order to model how the human visual system perceives the color of an objet. It transforms tristimulus values (XYZ) derived from the relative Reflectance spectra of an item surface to the **corresponding perceptual attribute correlates as viewed under a reference white**. Color Spaces are derived from at least three of the perceptual attributes in order to describe color and to measure color quality. CIELAB, the most commun CAM and color space used in conservation, while visually uniform, poorly relates to visual color difference (fig.1). Fairchild and co-authors developed CIECAM02 (2002) in order to address this last issue.

CIECAM02 transforms tristimulus values viewed under a wide range of conditions **to the corresponding perceptual attribute correlates as viewed under the perfect diffuser lit by the equi-energy spectrum illuminant**. **Therefore** the appearance of the color viewed under its given range of conditions matches the one of its corresponding color viewed under **the equi-energy spectrum illuminant.** In this model, the corresponding color of the stimuli is described in terms **of Lightness (J**), **Chroma (C**) and **hue angle (h**) in the CIECAM02 derived uniform color space. In order to predict the observed appearance, CIECAM02 must take into account the tristimulus value of the viewed object (XYZ), its background (Y_b), its surround and the luminance level of the adapted field (L_A). The later corresponds to the entire room where the item is viewed. The optimized color difference formula $\Delta E_{CIECAM02\text{-}op}$ developed in 2007 by Urban has been is used in this work.

CIECAM02 performances have been compared with the ones of CIELAB for two preventive conservation related applications. Figure 2 presents the workflow followed in order to **compare color appearance of a pair of juxtaposed colors viewed under two light sources**. Only CIECAM02 allows comparisons of not only the **Color Rendering** but also the **Color Constrast Rendering** under each condition. Figure 3 presents **the impact of respective fading on the rendering of juxtaposed pair of colors.** Again CIECAM02 presents interesting features as it also takes into account the fading of the juxtaposed color which also plays a role on the appearance change. The associated tables provide with numerical data for each application and show better performances of CIECAM02 over the ones of CIELAB.

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All sample appearance renderings were realized using a modified version of NIST CQS version 7.4 written by Y. Ohno and W. Davis (2008).

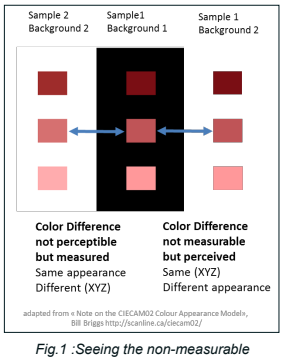

Fig.1 :Seeing the non-measurable

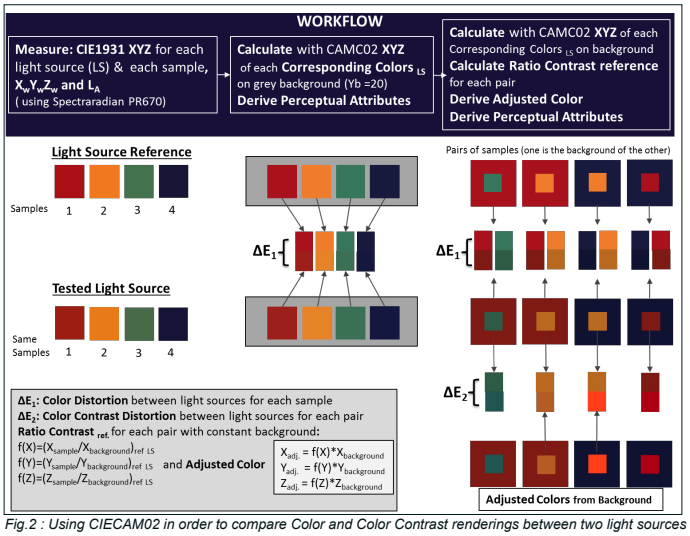

Fig.2 : Using CIECAM02 in order to compare Color and Color Contrast renderings between two light sources

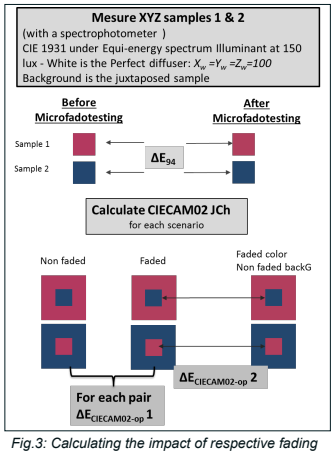

Fig.3: Calculating the impact of respective fading on the rendering of juxtaposed pair of colors

Color Distortion ΔE_1 between light sources (at ~ 1500 Lx) on grey background (Y_b = 20% Y_w)	LED MR16/Sylvania			
	Green	Red	Orange	Blue
ΔE_{94}	2.45	2.73	3.38	1.47
$\Delta E_{CIECAM02\text{-}op}$	3.77	4.26	6.11	1.53

Table1 : Comparing Color rendering of samples on grey background under 2 light sources using CIECAM02

Color Distortion ΔE_1 between 2 light sources (Sylvania & LED MR16, L_A ~ 300 Lx) (Y_b = Y of juxtaposed sample or Y of sample itself if background)	$Green_{on\ Red}$	$Orange_{on\ Red}$	$Red_{Background}$	$Orange_{on\ blue}$	$Red_{on\ blue}$	$Blue_{Background}$
ΔE_{94}	2.45	3.38	2.73	3.38	2.73	1.47
$\Delta E_{CIECAM02\text{-}op}$	3.55	6.00	3.89	4.99	3.43	2.72

Table2 : Comparing Color rendering of juxtaposed samples under 2 light sources using CIECAM02

Color Contrast Distortion ΔE_2 between light sources (Sylvania & LED MR16, L_A ~ 300 Lx)	Red/Blue	Orange/Blue	Orange/Red	Green/Red
ΔE_{94}	10.71	17.17	6.29	11.22
$\Delta E_{CIECAM02\text{-}op}$	19.96	25.46	8.83	33.51

Table 3 : Comparing Color Contrast rendering of pair of juxtaposed samples under two light sources

Color Change (before and after fading)	ΔE_{94}	$\Delta E_{CIECAM02\text{-}opt\ 1}$
$Blue_{Background}$	0.95	0.69
$Blue_{on\ Pink}$	0.95	0.67
$Pink_{Background}$	1.64	1.57
$Pink_{on\ Blue}$	1.64	1.62

Table 5 : Color Change due to fading of pair of juxtaposed colors

Color Change due to background	ΔE_{94}	$\Delta E_{CIECAM02\text{-}opt\ 2}$
$Pink_{BackG} - Pink_{on\ Blue}$	0	3.38
$Blue_{BackG} - Blue_{on\ Pink}$	0	4.51
$(Pink_{BackG} - Pink_{on\ Blue})_{Faded}$	0	3.37
$(Blue_{BackG} - Blue_{on\ Pink})_{Faded}$	0	4.57

Table 4: Color Change of sample due to color of its background

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