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The Dark Side of Color VII

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ABSTRACT

This year, at Electronic Imaging 2015, as part of the "Color Imaging XX: Displaying, Processing, Hardcopy, and Applications" conference, we hold the seventh annual special session entitled, "The Dark Side of Color". This session aims at introducing innovative thinking, opening discussion from experts working in a wide range of disciplines related with color, fostering ideas and stimulating ongoing issues and revealing common misunderstanding in color science and technology. It is comprised of a limited number of invited short presentations that are presented as summaries in this paper together with an overall description of the session point of view.

Keywords: Dark side of color, Color, Color models, Color teaching, Colorimetry, Vision, Color related phenomena

1. WHAT THIS SESSION IS ABOUT

Color is a very complex phenomenon that cannot sufficiently be explained using only simple physical principles. Instead, a more holistic approach incorporating the human vision system of eye and brain is needed to understand how the base physical stimuli are transformed into the visual colors we see.

Color related topics are often taught and communicated without presenting their inner complexity, their limits and the simplifications that generally are taken at some point. Dealing with color is usually reduced to the automatic and repetitive use of pre-defined "recipes" and this can lead to the risk of loosing the overall framework and consequently a correct understanding of the technique to use.

Classic colorimetric methods, specifically designed to deal with color in aperture mode (isolated, out of visual context), have become dominant in digital color science and technology. Their use has been extended to deal with a great variety of situations in which color is considered within a visual context, thus outside of its initial scope. As such, the aperture approach has been very successful in describing a vast number of color effects. However, in some cases, an extension of the aperture view seems problematic, since the context plays a major role. Color science is facing this transitional evolution in order to deal with color in context and appearance, but without substantial changes in their original foundation.

There is a need for widening the scientific debate and discuss about paradigms. This can be achieved by, for example, new questions, different attention for details; information in the margins that so far are often discounted or overlooked. These aspects are what we consider to be the "dark side of color".

The invited speakers of this session have been asked to stimulate ideas and discussions on the needs and the characteristics of possible alternative approaches and/or point of view. This session aims at suggesting paradigm shifts, lateral thinking and bottom up experimentation by re-addressing the current state of the evolving situation in color in sciences, arts and technologies.

Following these principles, every speaker has chosen a topic of his/her preference and presents open issues and problems in a short 15-minutes presentation. The presentation abstracts are reported in the following paper to give the reader a glance on the discussed topics.

We would like to stress that basically no answers are expected to arise from the presentations of this session, but more likely questions and perspective shifts.

2. THE SPEAKERS

Here are the abstracts of the speakers that will participate at this Dark Side of Color session. The last presentation will be introductive to the special session about new perspectives on color deficiency.

2.1 "How colorful! - A feature it is, isn't it?" Fritz Lebowsky, ST Microelectronics (France)

A display's color subpixel geometry provides an intriguing opportunity for improving readability of text. True type fonts can be positioned at the precision of subpixel resolution. With such a constraint in mind, how does one need to design font characteristics? On the other hand, display manufactures try hard in addressing the color display's dilemma: smaller pixel pitch and larger display diagonals strongly increase the total number of pixels. Consequently, cost of column and row drivers as well a power consumption increase. Perceptual color subpixel rendering using color component subsampling may save about 1/3 of color subpixels (and reduce power dissipation). This talk will try to elaborate the following questions, based on simulation of several different layouts of subpixel matrices: Up to what level are display device constraints compatible with software specific ideas of rendering text? Can simplified models of human visual color perception be easily applied to text rendering on displays? How linear is human visual contrast perception at band limit of spatial resolution? How much does visual acuity vary at 20/20 vision? How to best consider preferred viewing distance for readability of text? How colorful does the rendered text appear on the screen? How much of color contrast will remain? How much does viewing angle influence the performance of subpixel layouts and color subpixel rendering?

2.2 "Why simulations of colour for CVD observers might not be what they seem" Phil Green, Gjøvik University College (Norway)

A common task in universal design is to create a 'simulation' of the appearance of a colour image as it appears to a CVD observer. Although such simulations are useful in illustrating the particular problems that a CVD observer has in discriminating between colours in an image, it may not be reasonable to assume that such a simulation accurately conveys the experience of the CVD observer to an observer with normal vision.

Two problems with this assumption are discussed here. First, it risks confusing appearance with sensation. A colour appearance model can more or less accurately predict the change in appearance of a colour when it is viewed under different conditions, but does not define the actual sensation - the 'qualia'. As Wittgenstein and others have pointed out, such a sensation is ineffable and cannot be directly communicated but merely located on a scale with other related sensations. In Wittgenstein's example, the hypothesis that the sensation experienced by observer 1 when viewing a red object is the same sensation as that experienced by observer 2 when viewing a green object cannot be disproved. In practice we avoid this epistemological problem by asking observers to judge colour matches, relations and differences, none of which requires examination of the sensation itself. Since we do not truly know what sensation a normal observer experiences, it seems unscientific to suppose that we can do so for CVD observers.

Secondly, and following from the above, the relation between stimulus and corresponding sensation is established as part of neural development during infancy, and while we can determine the stimulus we cannot readily determine what sensation the stimulus is mapped to, or what the available range of sensations is for a given observer. A plausible hypothesis that the same range of sensations are available to CVD observers as to normal observers, but that the CVD observer has difficulty in differentiating between certain stimuli and thus consistently experiencing the same sensations as the normal observer. This does not preclude the possibility that the 'red' and 'green' sensations experienced by the normal observer are available to the CVD observer under the right conditions, and if this were the case it might suggest potential avenues for future research.

3. THE PREVIOUS DARK SIDE SESSIONS

Here is a list of the speakers and topics that have participated at the previous Dark Side of Color sessions.

3.1 The dark side of color I (2009)

"Well asked questions" Reiner Eschbach
"Pictorial information as transcribed by the artist or designer" Stephen Hoskins
"Consider the Size: And Other Display Features" Garrett M. Johnson

“Adaptation! … What Adaptation?” John McCann
“The Opposite of Green is Purple?” Nathan Moroney
“Now...what color was that again?” Sabine Süsstrunk
“Stepford – the city for Colour Engineering” Stephen Westland

3.2 The dark side of color II (2010)

“Color naming: color scientists do it between Munsell Sheets of Color” Giordano Beretta and Nathan Moroney
“Size matters: The problem of color-difference estimation for small visual targets” Robert C. Carter and Louis D. Silverstein
“Controlled versus uncontrolled viewing conditions in color evaluation” Reiner Eschbach
“Mind over Matter” Jennifer Gille
“Globalization of color” Paul Hubel
“The appearance of illusions and the delusion of reality” John McCann

3.3 The dark side of color III (2011)

“The Color Side of Dark” Raja Bala
“What a bad signal from this strange device!” Alessandro Rizzi
“HDR Imaging and Color Constancy: Two Sides of the Same Coin?” John McCann
“Is the future of digital printing paperless?” Giordano Beretta, Eric Hoarau, Jun Zeng
“Can less be more?” Jan Allebach
“Can displays go wild?” Gabriel Marcu

3.4 The dark side of color IV (2012)

“The dark side of CIELAB” Gaurav Sharma and Carlos Eduardo Rodriguez-Pardo
“Complexitites of complex contrast” Eliezer Peli
“It's not the pixel count, you fool” Michael A. Kriss
“Color imaging and aesthetics: is there the cheshire cat?” Elena A. Fedorovskaya
“Dark texture in artworks” Carinna E. Parraman
“Harmonious colors: from alchemy to science” Giordano B. Beretta, Nathan M. Moroney

3.5 The dark side of color V (2013)

“Can trichromats really know what dichromats see?” Michael H. Brill, Datacolor (United States)
“Color scales for visualization: traveling though color space” Bernice E. Rogowitz, Visual Perspectives Consulting (United States)
“Color spaces” Jan J. Koenderink, Technische Univ. Delft (Netherlands)
“You can't rely on color, yet we all do” Floris L. van Nes, Technische Univ. Eindhoven (Netherlands)
“How 'high-level' is human color perception? Michael E. Rudd, Univ. of Washington (United States)
“Complex spatiochromatic interactions in a real world art laboratory” Scott Daly, Dolby Labs., Inc. (United States)

3.6 The dark side of color VI (2014)

“ColorChecker at the beach: dangers of sunburn and glare” John J. McCann, McCann Imaging (United States)
“The bright future of metameric blacks” Philipp Urban, Fraunhofer-Institut für Graphische Datenverarbeitung (Germany)
“Feeling edgy about color blindness” Reiner Eschbach, Stephen Morgana, Xerox Corp. (United States); Anna Quaranta, Cristian Bonanomi, Alessandro Rizzi, Università degli Studi di Milano (Italy)