

Review on Saliency-Based Feature Assessment for Color Deficients

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ABSTRACT: The difference in pursuing colors happens because of photo pigments in retinal cones. It is hard to measure the one's ability to apprehend colored scenes and predict its effects on the behaviours. A method for measure and apprehend information loss and gain based on ability to predict visual scenes is developed here. This method is based on visual salience. A visual salience for color deficient is found out first, the corresponding losses and gains is predicted from comparison of color deficient and normal observer.

KEYWORDS: vision; individual difference; color deficiency; saliency.

I. INTRODUCTION

The extend of individual's experience somewhat depends on differences in perception of senses. Color-sensitive photo pigments change individual's perception of intricate visual scenarios. Therefore, individuals suffer through differences in visual perception. Most of the humans are trichromatic, i.e., colors are perceived by the population-activity of long-wavelength (L), middle-wavelength (M), and short-wavelength (S)-sensitive cones. Individuals lacking one set of photo pigments develop color discrimination; i.e., they are blind to the difference between a certain pair of colors, such as red or green. The genetic polymorphism is the major consequence of divergence in color vision (Fig. 1a). There are presently some practical methods to compensate such color-vision deficient (CD) observers medically so as to have common trichromatic vision; however gene therapies under development may shortly provide a cure. An alternative technique to potentiate visual accessibility for CD observers is the compensatory design of visual material with sufficient information to be perceived by all viewers, including CD observers.

The visual experiences of CD individuals can be graphically mimicked by replacing each set of indistinguishable colors by a single color chosen from one of the chromatic confusion lines of dichromats (Fig. 1b). This technique provides accurate chromatic metamers for dichromats. However, interpretation of simulation results is problematic because the selection of representative colors is not determined uniquely but has ambiguity that totally relies on the algorithm being used. For instance, various sequences of red, green, and yellow can be used to simulate the visual aspect of those colors in "red-green" dichromat vision. Moreover, it has been complex to standardize unstructured visual information, such as natural images, directly from these simulations. It is tough to choose the best image parameters because the version of a simulation's output depends on subjective impressions by the viewers, and comparing subjective impressions like color perception among observers is not straightforward. A likely approach to compare such subjective experiences is mapping the high-dimensional perceptual information onto a common low-dimensional subspace and defining a perceptual difference metric as the distance measured in that subspace. A naïve manner to do this is to measure the chromatic contrast (distance in a specific color space) in the simulated images, but the ambiguity in color mapping remains unsolved. Sometimes dichromatic vision proves superior to normal trichromacy; in that case simple color-difference approach is not efficient: Dichromat observers have advantages at finding camouflaged objects (e.g., predator/ prey in the natural habitat) against a multicolored background.

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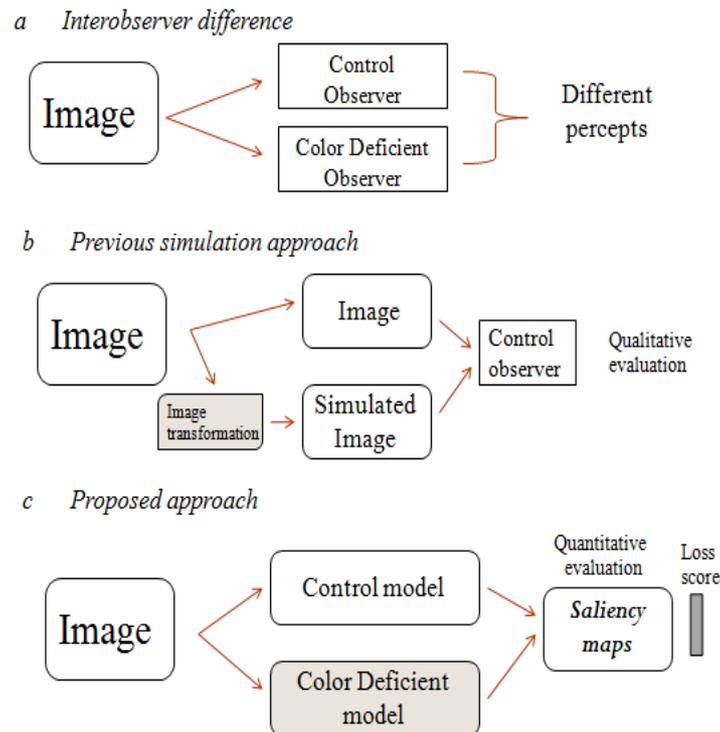


Fig.1. (a) Interobserver differences. (b) Previous simulation approach. (c) Proposed approach.

In this study, visual saliency as an alternative to quantify perceptual differences is proposed (Fig. 1c). Visual saliency concept was first proposed in the context of cognitive science, and later computational implementations were studied. Saliency is used to a great degree in studies on human visual attention; for example, many properties of bottom-up visual attention in trichromatic human observers are predicted by saliency models. Although the term “saliency” reflects different aspects of perceptual performance, which includes eye movements, in this study this term will be used to denote the visual conspicuity predicted from image parameters. Visual saliency potentially accounts for the complexity in the relationships between color vision and cognitive ability. However, there have been few researches that have studied the saliency model and its behavioural implications for observers lacking trichromatic color vision; for instance, psychophysical study suggests that color information interacts with visual object representation at multiple processing levels. In order to test the relevance of saliency analysis to human perception, a psychophysical method is developed where the perceptual content across observers in terms of visual saliency is compared, and theoretically derived saliency-loss value (L) is correlated with the difference in subjective perceptual appearance reported by normal and CD observers. In addition to this, different studies revealed that this difference in image preference can be fixed by manipulating the visual stimuli so that there will be a low saliency difference between trichromat and CD observers, and so establishing a causal relationship between the quantified saliency and the perceptual judgments by observers. These results emphasize the competency of the present saliency-based approach for measuring perceptual divergence resulting from deficiency in color vision and its capability for relating color vision polymorphism and behavioural divergence. This approach also yields a promising and practical strategic technique for the design of visual content accessible by observers having a range of spectral sensitivities, including those with color deficiency.

Paper is organized as follows. Section II describes saliency methods using various algorithms and techniques. Section III represents the methodology to be followed in this research where saliency maps for each trichromatic and

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dichromatic simulations is calculated, so based on differences between saliency maps, the loss i.e. information loss for color deficient is evaluated. Finally, Section IV presents conclusion.

II. LITERATURE SURVEY

Human eye is particularly more sensitive to certain colors and intensities and objects with such features are called salient. Salient image feature's detection is useful in applications such as object dependent image retrieval, adaptive content passing, image compression, and image resizing. The detection of salient image features can be handled by mapping the pixels into various feature spaces. This paper has proposed a technique that encapsulates K-Means Clustering with Saliency detection to determine salient areas in images using low-level features of luminance and color and then the features are extracted. This technique is easy to implement, computationally competent and produces high quality saliency maps and saliency object of the same size and resolution as that of input image. The proposed methodology identifies salient regions as those regions that are visually more conspicuous by virtue of their contrast with respect to surrounding regions [4].

A novel Boolean Map based Saliency (BMS) is proposed here. An image is basically distinguished by a set of binary images, where binary images are generated by arbitrarily thresholding the image's color channels. BMS computes saliency maps by analyzing the topological structure of Boolean maps which is based on Gestalt principle of figure-ground segregation. BMS is easy to implement. Despite being simplicity, BMS has continuously achieved state-of-the-art performance in comparison with leading methods on eye tracking datasets. Moreover, BMS is advantageous in salient object detection. [5]

Visual saliency allows reliable processing of images without prior knowledge of their features, which is the reason why it became an important step in many computer vision applications including image compression, object recognition, and segmentation. A regional contrast based saliency extraction algorithm is proposed in this paper, which also tests global contrast differences and spatial coherence. The algorithm is simple and yields full resolution image saliency maps. It has outperformed existing saliency detection methods, producing higher precision and better recall rates, when evaluation was done on one of the largest publicly available data sets. How the produced saliency map can be used to generate better quality segmentation masks for image processing is demonstrated here. [6]

Context-aware saliency detects the image regions that represent the scene. This method differs from previous methods where goal is to either identify fixation points or detect the dominant object. A detection algorithm which is based on four principles observed in the psychological literature is proposed here. This approach is evaluated in two applications where the context of the dominant objects is just as substantial as the objects themselves. In image retargeting, the proposed saliency prevents distortions in the important regions. This method helps to produce compact, appealing, and informative summaries. [7]

In image processing saliency estimation has become an important tool. Still, methods have variation in saliency techniques, and sometimes it becomes difficult to improve results to particular algorithm properties. In this paper, reconsider some of the design choices of previous methods are reconsidered and proposed a conceptually lucid and intuitive algorithm for contrast-based saliency. This algorithm contains four fundamental steps. First, it decomposes image into compact, perceptually homogeneous elements that abstract unnecessary details. Taking this abstraction forward, two measures of contrast are computed that determines the uniqueness and the spatial distribution of these elements. From the element contrast saliency measure is derived which produces a pixel-accurate saliency map that uniformly covers the objects of interest and separates fore- and background consistently. The complete contrast and saliency estimation can be formulated in a specialize way using high-dimensional Gaussian filters. This method is conceptually simple, highly efficient to implement. When compared with all state-of-the-art approaches, it outperforms in terms of experimental evaluation and analysis. [8].

Detecting change of remote sensing images is significant for applications such as tracking of moving objects and motion estimation. Traditional work on remote sensing detection has largely been dependent on segmentation approaches of a single image feature. The results of traditional change detection approaches is affected by noise, blur, contrast and brightness level. To overcome the problem of earlier approaches, the Itti visual saliency model is improved where saliency map is used to detect real change regions between two remote sensing images of a given scene acquired

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at different times. The results of various experiments indicate that this approach is robust to noise, contrast and brightness level. [9]

This paper describes a novel approach for extraction objects of interest from a given image. Multiple objects are extracted by the application of saliency detection on the image. The two distinct approaches for object extraction are used here. First approach utilizes super pixels on the saliency map where intensity of saliency map in each super pixel is used to compute distance between the centres of super pixels, this act as constraints to extract the objects from the image. The other approach is the application of Active Contour model on the saliency map where a bounding box on the intermediate binary image is estimated which extracts the objects in the image. The approach is unique as it does not use extensive image search like the existing algorithms and therefore leads to efficient and fast algorithm. [10]

Visually salient image detection is useful for applications like object segmentation, adaptive compression, and object recognition. A method for salient region detection that outputs full resolution saliency maps with well-defined boundaries of salient objects is proposed in this paper. These boundaries are achieved by retaining more frequency content from the original image compared to other existing techniques. This method exploits features of color and luminance, is simple to implement. When compared with five state-of-the-art salient region detection methods with a ground truth, frequency domain analysis and a salient object segmentation application; this method proves to be efficient. This method outperforms the five algorithms both on the ground-truth evaluation and on the segmentation by achieving both higher precision and better recall. [11]

To automatically cutout the object-of-interest is a challenging due to lack of information of the object-of-interest and the background. Saliency techniques provide information about object-of-interest by highlighting high-contrast or high attention regions or pixels. Although, saliency map is often noisy and when applied to segmentation leads to erroneous outputs. In this paper, use of user input image for segmentation as a query image to Google Images is proposed and then top returned Google images is employed to build up the knowledge about the object-of-interest in the user input image. Particularly, a lightweight algorithm is developed. The enhanced saliency map generated is used to initialize the graph-cut to extract the object-of-interest. When demonstrated with McGill dataset and multiple challenge cases, this method proves to be effective in terms of producing a clean cutout. [12]

III. PROPOSED METHODOLOGY

The color perception between dichromatic and trichromatic observers while viewing complex visual scenes can be differentiated by the metric of saliency loss (L). If there are saliency maps derived from visual processing models of trichromacy and dichromacy, the divergence between the maps will perfectly capture the characteristics of perpetual differences between the observers. The visual saliency divergence is derived in three steps: (1) Early sensory system model, (2) Saliency maps derivation, (3) Quantification of saliency maps. By changing their parameters, the first two steps can be applied to different visual processing models.

First, the early sensory encoding of color, luminance, and orientation is predicted according to models of the cone distribution and subsequent opponent-color processing is also computed (Figs. 2a and 2b). The previously proposed simulation methods do not consider the color-opponency system and reconstruct the images on the basis of cone response (LMS) to simulate the color differences experienced by dichromat. A more biologically plausible model of color opponency is introduced in the early visual system (Table. I); here, the chromatic information is presented in the Derrington-Krauskopf-Lennie (DKL) color space, which gives the preferences of retinal ganglion cells and lateral geniculate nucleus (LGN) neurons and describe the bottom-up saliency attention resulting from early visual system.

There is no established color space model for dichromat or anomalous trichromats to-date, although few studies suggest that "red" and "green" can be discriminated by the variations in the optical density of pigments or other nonlinear computations based on existing LMS cones. In this study, it is simply assumed that the color opponency of the missing cone type is not present (Fig 2b): e.g., in the computation of the luminance and chromatic signals, an "L+M" signal was substituted with M for protanopia, and with L for deuteranopia. The L-M dimension is not computed for protanopia and deuteranopia, while the S dimension is not computed for tritanopia. Opponent-color spaces for anomalous trichromats are modelled as the common trichromat but with different cone sensitivity functions: The L (M) cone sensitivity functions for protanomaly (deuteranomaly) observers are utilized. This model follows basic findings in the anatomical

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connectivity in the early visual systems and a previously verified model, without having any unreported physiological connections. The point of model is to introduce the information loss at the level of opponent color coding.

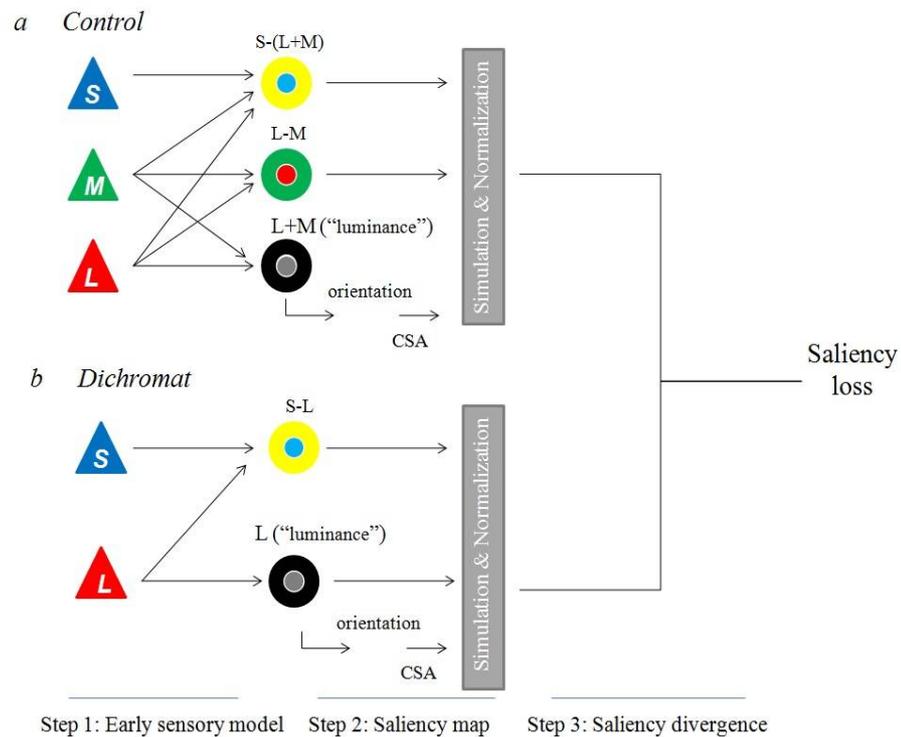


Fig. 2. Saliency loss computation (a) A model of trichromatic vision saliency maps. (b) Hypothetical computation of dichromatic vision saliency map. CSA: Center-Surround Antagonism.

TABLE I.

MODELS OF EARLY VISUAL SYSTEMS FOR DIFFERENT COLOR DEFICIENTS

	CONES			OPPONENT SIGNALS		
	S	M	L	BLUE-YELLOW	RED-GREEN	LUMINANCE
Protanope	*	*	-	S-M	-	M
Deuteranope	*	-	*	S-L	-	L
Tritanope	-	*	*	-	L-M	L+M
Common	*	*	*	S-(L+M)	L-M	L+M

IV. CONCLUSION

A novel approach for quantifying and presenting interobserver differences in perceptual experience is proposed because there are individual variations in spectral sensitivity. There is a strong statistical relationship between saliency loss or gain and the subjective judgment of saliency. Moreover, saliency-guided image manipulations are sufficient to

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compensate for interobserver differences in saliency. Thus, matching visual saliency is a promising strategy for ensuring that visual information is accessible to individuals with deficient color vision.

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