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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 measurement and apprehend information loss 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 loss of information is predicted from comparison of color deficient and normal observer.

KEYWORDS: **Vision; 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. 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.

In this study, visual saliency as an alternative to quantify perceptual differences is proposed. Visual salience 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.

II. RELATED WORK

H.Brettel, F. Vienot and J. D. Mollon [2] presented model on computerized simulation of color appearance for dichromat. Color vision deficiency affects approximately 200 million people worldwide, compromising the ability of these individuals to effectively perform color and visualization-related tasks. This has a significant impact on their private and professional lives. A physiologically-based model for simulating color vision is there. This model is based on the stage theory of human color vision and is derived from data reported in electrophysiological studies. It is the first model to consistently handle normal color vision, anomalous trichromacy, and dichromacy in a unified way.

G. M. Machado, M. M. Oliveira and L. A. F. Fernandes [3] propose a physiologically-based model for simulation of color vision deficiency. A computerized simulation of dichromatic vision in which the dichromat's color confusions and color palette are correctly represented for normal trichromats. Because dichromatic vision is a reduction of

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trichromatic vision, it should be possible to simulate for trichromatic observers the color gamut of dichromats. The simulation, for the normal trichromat, of dichromatic vision should not only reproduce the dichromat's color confusions but also offer a plausible color appearance. The color confusions are easily deduced from colorimetry. Dichromats confuse lights that differ only in the missing class of cones and can discriminate colors only on the basis of the responses of the two remaining cone types. In other words, one of the three colorimetric components that are required to specify a color stimulus in terms of the L, M, and S-cone spectral responses is physiologically undetermined for a dichromat. As the dichromat does not see any change in the physiologically undetermined component, its value can be deliberately chosen so as to imitate for the normal observer the appearance of colors for the dichromat. To this end, color percepts of dichromats are used. On the basis of these reports, several assumptions concerning the hues that appear the same to dichromatic and to normal observers are presented. These common hues define the color stimuli that remain invariant through the color-space transformations. First, it is assumed that neutrals for normals are perceived as neutrals for dichromats. Accordingly, no neutral stimuli are to be changed by the simulation. Second, it is inferred from reports on unilateral inherited color vision deficiencies that a stimulus of 575 nm is perceived as the same yellow, and a stimulus of 475 nm as the same blue, by trichromats as by protanopes and deuteranopes. Third, drawing upon a case of unilateral acquired tritanopia, we assume that the corresponding two hues for a tritanope are a red with a dominant wavelength of 660 nm and a blue–green with a dominant wavelength of approximately 485 nm. Taken together, these studies on the color perception of dichromats define the algorithm where the replacement value of the physiologically ineffective LMS component is determined.

L. Itti, C. Koch and E. Niebur[4,5] presented a basic model of visual attention. This framework suggests that subjects selectively direct attention to objects in a scene using both bottom-up, image-based saliency cues and top-down, task-dependent cues. But the shortcoming of this model is that it produces saliency maps that are just 1\256th the original image size in pixels.

X. Hau and L. Zhang [6] proposed a model of saliency detection based on a spectral residue approach. This work presents a simple method for the visual saliency detection. This model is independent of features, categories, or other forms of prior knowledge of the objects. By analyzing the log-spectrum of an input image, it extracts the spectral residual of an image in spectral domain, and propose a fast method to construct the corresponding saliency map in spatial domain. The shortcoming of this model is that output maps are of size 64×64 pixels for any input image size.

Federico Perazzi, Philipp Krahenbuhl, Yael Pritch, Alexander Hornung [7] presented contrast Based Filtering for Salient Region Detection. In this method the complete contrast and saliency estimation is formulated in a unified way using high dimensional Gaussian filters. But the shortcoming of this model is that saliency estimation based on color contrast may not always be feasible, e.g., in the case of lighting variations.

III. PROPOSED SYSTEM

To compare the color perception between trichromatic and dichromatic observers when viewing complex visual scenes, metric of saliency loss is introduced. The two saliency maps derived from two different visual processing models (e.g., trichromacy and dichromacy), the structural divergence between the maps will ideally capture the characteristics of perceptual differences between the two observers.

I. SOFTWARE MODULE

The model differentiates the saliency map for trichromatic and dichromatic observers which give loss of information for color deficient observer. The current approach is potentially able to differentiate perceptions resulting from different types of color deficiency. The following flow diagram is for the system implemented on the MATLAB;

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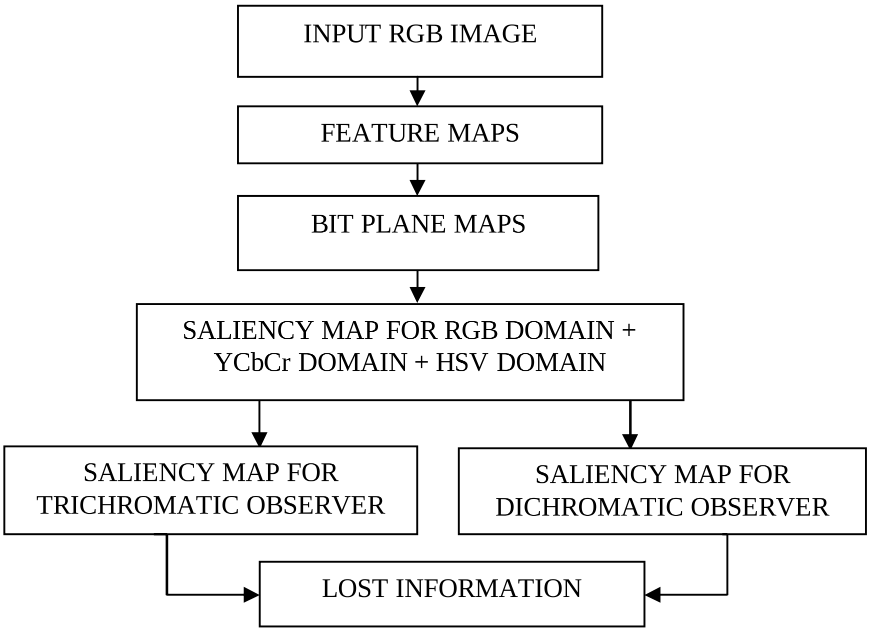

Figure 1: Flow diagram for the system implemented on MATLAB

1. *Image:* In the MATLAB workspace, most images are represented as two-dimensional arrays (matrices), in which each element of the matrix corresponds to a single pixel in the displayed image. For example, an image composed of 200 rows and 300 columns of different colored dots stored as a 200-by-300 matrix. Some images, such as RGB, require a three-dimensional array, where the first plane in the third dimension represents the red pixel intensities, the second plane represents the green pixel intensities, and the third plane represents the blue pixel intensities.
2. *Feature maps*: A feature maps are been calculated for obtaining different maps for color opponent maps and luminance map. An Image given as input in first block act as output for this block, considering different features maps are calculated.
3. *Bit plane maps:* Bit plane maps are calculated from different feature map contents as R, G, B, RG, BY, where these components of image are considered as inputs. Depending upon size of image bit plane maps are calculated. Generally, for 8 bit image, 8 bit planes are computed.
4. *Rough saliency map* : Considering the edge is getting clearer in every bit plane map, the clearer edge in the last bit plane map is considered as input, wherein mean of entire image is considered, applying conditions of mean of an image, rough saliency map is derived.
5. *Saliency map RGB*: The saliency map is calculated in RGB color domain.
6. *Saliency map YCbCr*: As the saliency map for RGB domain is calculated, similarly it is calculated for YCbCr domain, where luminance and chrominance component of an image is considered.
7. *Saliency map HSV*: As the saliency map for RGB domain is calculated, similarly it is calculated for HSV domain, where hue and saturation value of an image is considered.
8. *Super saliency map*: Combining the saliency maps of RGB, YCbCr and HSV domain, super saliency map is calculated. The super saliency map is calculated for trichromatic observer. Using the same algorithm saliency map for dichromatic observer is calculated.
9. *Information loss:* The saliency map is derived for trichromatic observer first; similarly it is calculated for dichromatic observer. The difference between the two maps gives the information loss *i.e.* loss of color information by color deficient.

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II. HARDWARE MODULE

A scheme of saliency based color accessibility is used to find out loss of color information for person suffering from color blindness. The proposed method suggests the implementation of the system using field programmable logic array (FPGA). Implementation of dichromatic color deficient model using proposed architectures is investigated to compare the characteristics of image related to its color in order to evaluate the loss of information for observer. As shown in Figure 2, input image taken from MATLAB, where data is in pixels form, this data is given to serial conversion kit through which it becomes input to FPGA kit and FPGA kit provides output which can observed on MATLAB. Image is processed on FPGA platform on NIOS II processor.The system can be implented on Altera DE2 board, the flow diagram for the same can be seen below;

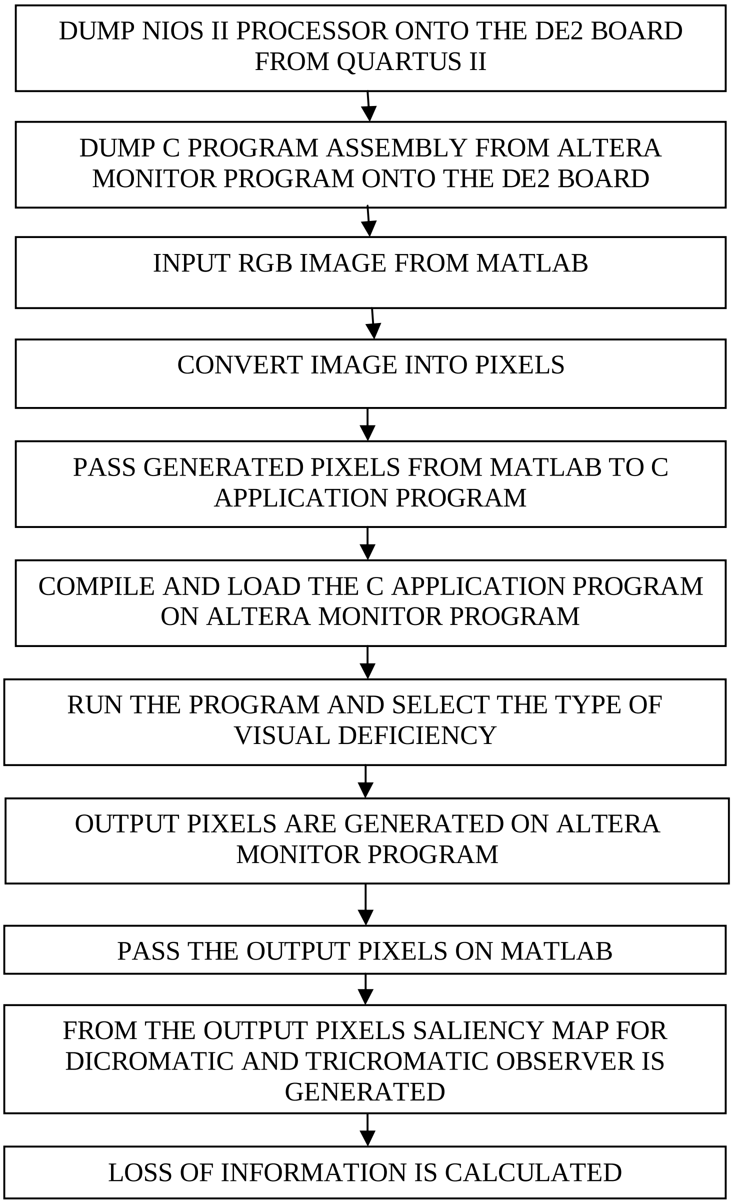

Figure 2: Flow diagram for the system implemented on Altera DE2 board

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In order to process image on Altera DE2 NIOS II, image is taken from MATLAB platform. With thousands of pixels to keep track of, it can be downright scary to the occasional programmer. The image is broke down to pixels. To start with, if use a RGB picture of size 480×640 of 32 bit, each of the pixels in a picture has one value. Instead of pixels we get 2D array, this 2D array is stored in a text file. Now that images are basically 2D arrays, we have to create image object in C application program in NIOS II processor. The output image pixels created from NIOS II processor over C compiler needs to get back on MATLAB platform to form the processed output image.
Contents for the system development are as follows;

- Nios II System
- Altera's SOPC Builder
- Integration of the Nios II System into a Quartus II Project
- Running the Application Program

IV. RESULTS AND ANALYSIS

The model not only differentiates the saliency map for tritanopes from the other two dichromatic visions, but also yields slightly different predictions. This is because the difference in cone combination (i.e., L and S, or M and S) can lead to different luminance signals, in addition to the primary effect of lacking an L-M signal. This fact indicates that the current approach is potentially able to differentiate perceptions resulting from different types of color deficiency. The saliency map is derived for trichromatic observer first; similarly it is calculated for dichromatic observer.
The saliency map is derived for trichromatic observer first; similarly it is calculated for dichromatic observer. The difference between the two maps gives the information loss i.e. loss of color information by color deficient. A new approach for quantifying and presenting interobserver differences in perceptual experience is simulated. These results revealed a strong statistical relationship between saliency loss subjective judgments of saliency. Furthermore, it is also found that saliency-guided image manipulations were sufficient to 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.

Figure 3: Result of information loss for Protanopia for Image_4.jpg of size 64×64

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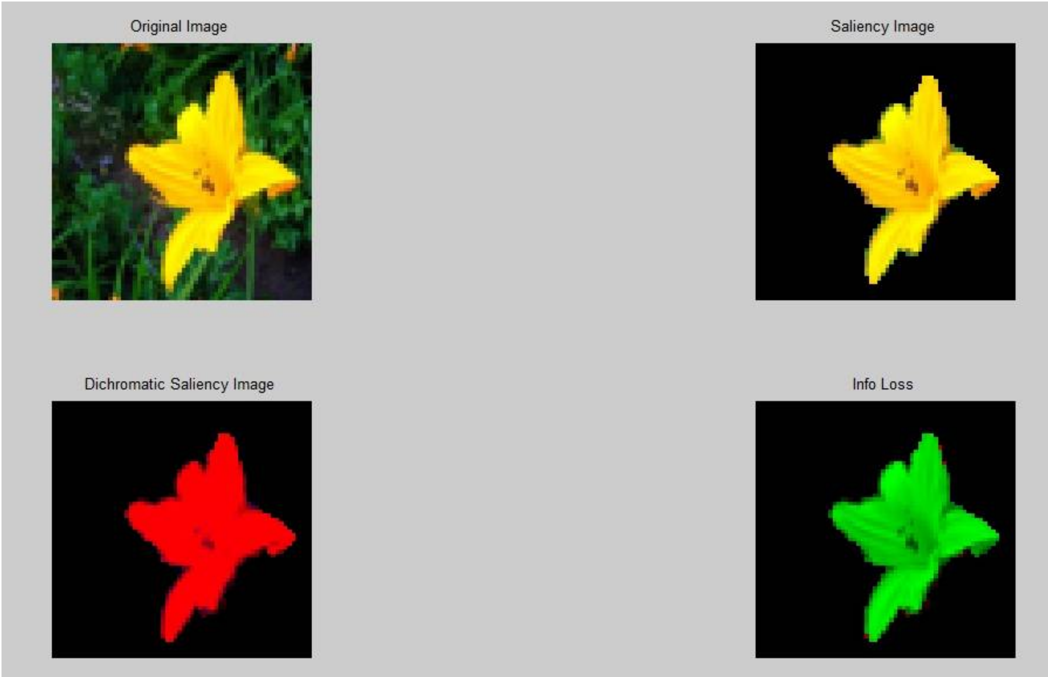

Figure 4: Result of information loss for Deuteranopia for Image_4.jpg of size 64×64

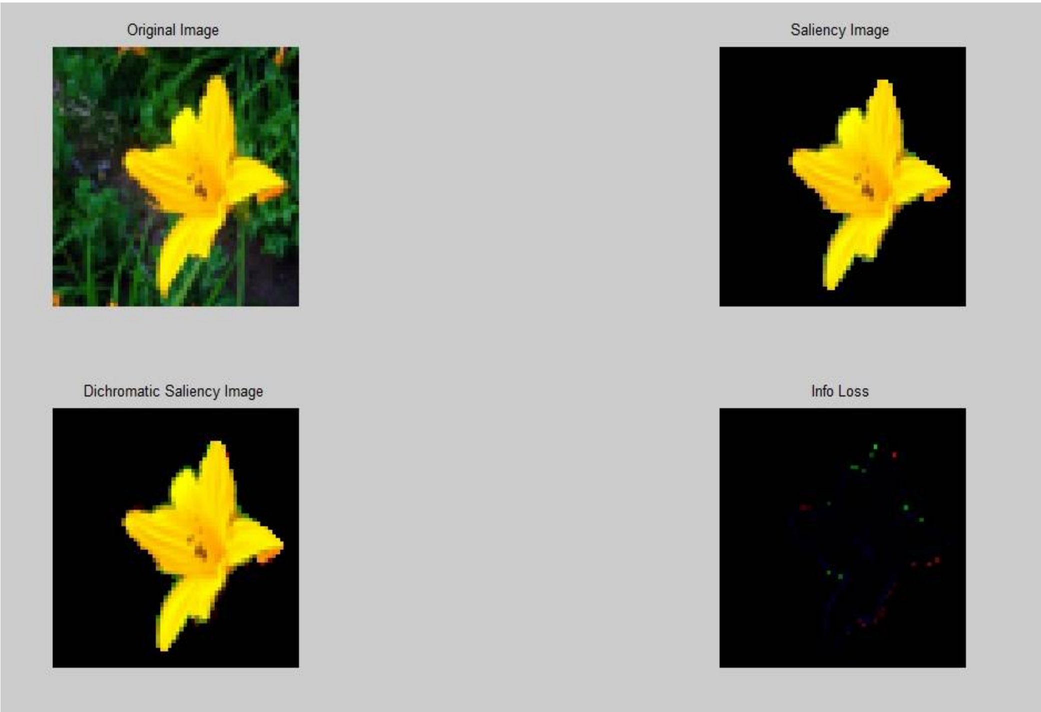

Figure 5: Result of information loss for Tritanopia for Image_4.jpg of size 64×64

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1. Precision calculation

In software and hardware modules, the comparison of the average saliency judgments of the control and CD observers was consistent with predictions of the model. These results support the plausibility of the deuteranope simulation and the saliency loss model for revealing individual differences in color perception.
Precision is calculated to see how the object of interest is been cropped from the image. The precision is applied over software and hardware modules. Considering different set of images applied for software and hardware module, we could actually form a judgement between the two methods. However, the time for simulation for hardware module is considerably more, because of having every pixel of the image being processed. If the average precision is calculated considering different set of images it comes out nearly 90 % for both the modules.

2. Execution time analysis

For processing of 32×32 image, hardware based algorithm the number of pixels to be processed on Altera DE2 board is 32×32×3 = 3072 while for 64×64, it is 64 ×64× 3 = 12280 and that for 128×128×3=16384, so the processing time for 128×128 image is more compared to that of 64×64, and the processing timing for 64×64 is more than 32×32. If width and height of image is changed then processing time is also varied accordingly. This processing time is also depends on system processor. If advanced processor is used for the given application, then time required for the execution will be very less. So, generally high end processing system is preferred over low processing system.
The following table gives the total time for evaluation according to different sizes of images and their precisions.

Table 1: Time for evaluation for different sizes of images and precision

Image	**Resolution**	**Number of pixels to be processed on DE2 board**	**Time for evaluation of saliency maps (seconds)**	**Precision (%)**
Image_4	32×32	3072	1.54	90
Image_4	64×64	12280	2.1	91
Image_4	128×128	16384	3.4	87
Image_26	32×32	3072	1.72	88
Image_26	64×64	12280	2.4	90
Image_26	128×128	16384	3.7	93
0326	32×32	3072	1.62	90
0326	64×64	12280	2.3	91
0326	128×128	16384	4.0	88

The following graph gives the time for evaluation for saliency model and total time execution for the entire system.

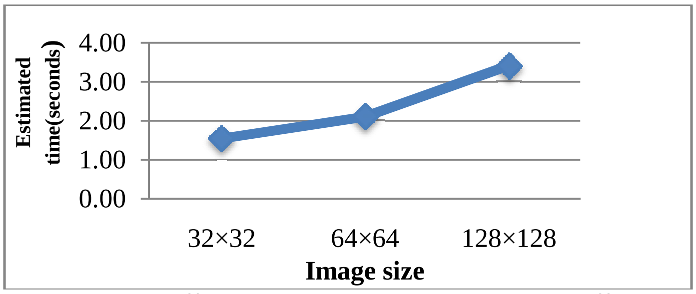

Figure 6: Graph indicating different estimated times according to different sizes of images

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It can be seen that as the sizes of images increases, time for calculation also increases. There is drastic change in time for image size 128×128 compared to that of 64×64 because of having to calculated more pixels on hardware board. It offers real time processing.

V. Conclusion

The availability of this model has allowed to develop an algorithm to simulate for normal observers how the dichromat perceives a complex colored scene. The point of this model is to introduce the information loss at the object of interest through saliency maps.The model is implemented on complete software platform on MATLAB and hardware platform on Altera DE2 board (NIOS II processor). Based on the performance analysis it is found that if the resolution of the input image is increased, the time for the processing is increased. Precision which gives the percentage of how the object is salienced from an entire image comes out to be more than 90% for both the modules.

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BIOGRAPHY

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