

Perception of Depth in Stereoscopic Image with the Change of Saturation

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Abstract. Color correction of stereoscopic images is focused on compensation of color inconsistency between left and right image in these days. In this paper, the relationship between change of color saturation of pixels and perceived depth information for stereoscopic images was analyzed. By the proposed method, we found if we decrease saturation values for some object in the scene, it looks like more farther than its real location. This fact can be utilized in reducing viewing fatigue for 3D stereoscopic images.

Keywords: Color correction, Stereoscopic images, Color Saturation

1. Introduction

Display device for 3D stereo image become popular in these days. Although, one takes some effort in capturing stage for 3D stereoscopic contents to have best environmental conditions, the captured left and right images shows inconsistency for pixel values and needs some correction for pixels as post-processing. In general, the post-processing corrects for discontinuity of depth information and inconsistency of color for left and right pixels with the same positions[1]. Most depth corrections depends on hand correction by human rather than computerized operations and corrected results have some distortion problem in depth information. For the correction of inconsistency of color, computerized operations can be adopted and do not modify the depth information directly. Therefore, the distortion of depth information does not occurs. Recently, some research[2-3] shows the relationship between color and perceptual depth information for human observer. They focused on hue only rather than intensity or saturation. In this paper, we would find the relationship between saturation change and perceptual depth information for human observer. The proposed method does not change input depth information and controls saturation only. The corrected image does not have discontinuity in depth information. It can be utilized in reducing the fatigue of 3D stereoscopic image observer.

2. Conventional Method for Experiment

According to the research on visual depth information for human being with the effect of psychological phenomenon[2], one can perceive different depth information from the objects with the same physical depth and different hue. In the research, warm colors such as red looks more closer than cool colors such as blue while the physical depth information gives the same value. And object with cool colors looks less closer than its real physical depth. The background for test were neutral gray and white. For the result, red colors give more close depth and blue colors less close. Yellow and green colors give midium depth characteristics. They analyzed this phenominon for hue only. In this paper, other color component such as saturation rather than hue will be analyzed.

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3. Proposed method for experiment

In this paper, we analyze the relationship between change of saturation for some synthetic object such as sphere and the perceived depth. The environment and procedure for the experiment are as follows:

STEP 1: 3D stereoscopic monitor set on the table

STEP 2: Display the stereoscopic image like Figure 1 sequentially with change of saturation and physical depth information. For example, The right image, 92% saturated sphere with most foreground position such as shown in Figure 2 like $k=1$ displayed first, then next displayed image would be 92% saturated sphere with $k=2$, and so on. After all the images for 5 positions displayed, saturation would be changed. Left image has maximum saturation and fixed for all the test images

STEP 3: The observer sits in front of 3D monitor on the table, distance between observer and table is about 2m or so.

STEP 4: The observer selects the best fit for STEP 2. The best fit means depth of two spheres looks like the same.

STEP 5: Write the best fit index k for the saturation

STEP 6: Repeat from STEP 1 to STEP 5 with change of saturation in STEP 2 like 84%, 76%, 68% and 60%.

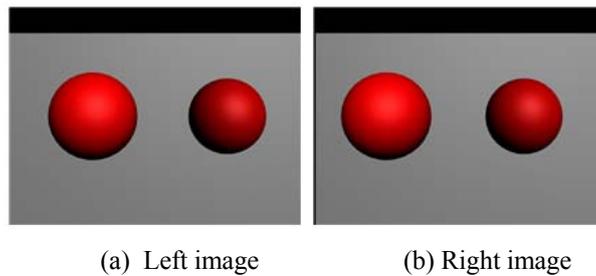


Fig.1 Test stereoscopic image.

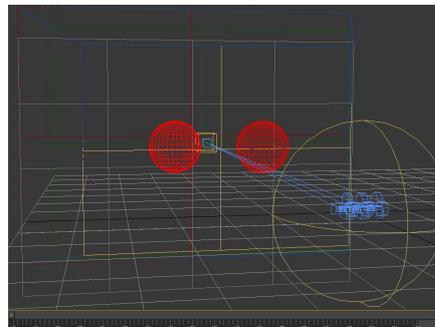
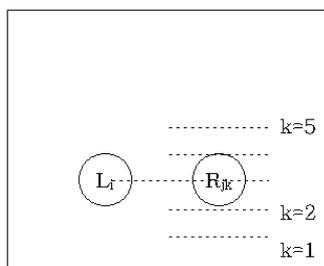


Fig.2 Environment for image capture (top view). Fig.3 Synthetic image capture environment using 3DS-MAX.

In Figure 2, L_i represents left reference object and subscript i means 5 reference test positions. We generated 5 image set with change of position $i = 1$ to 5. Each image set have 5 different images with change of k . R_jk represents the right test object and subscript j means change of saturation and k means relative position index for right object. If $j = 1$, it means 92% saturated object color. Therefore, we got 25 test images for each saturation values and finally 125 images for each color. Test images were captured by 3dhippie_stereocam Script for 3DS-MAX with change of position and color and saturation of spheres shown in Figure 3.

4. Experimental Results

The experiment was performed for color red first. The result for this color is shown in Table 1. The perceived depth for each saturation value can be estimated by the value of k . The resultant value of $k=2.5$ means the match was detected between $k=2$ and $k=3$. It means the matched position located between position

for $k=2$ and $k=3$. The right object was closer than the position with $k=3$ and farther than the position with $k=2$.

Tab.1 The matched depth index for the change of saturation values(k values)

Reference position / Saturation	j=1 (92%)	j=2 (84%)	j=3 (76%)	j=4 (68%)	j=5 (60%)
i = 1	2.5	2.5	2.5	2.5	2.5
i = 2	2.5	3.0	3.5	3.5	3.5
i = 3	2.5	2.5	2.5	2.5	3.0
i = 4	3.0	2.5	3.0	2.5	2.5
i = 5	3.0	2.5	2.5	3.0	3.5

The result for this experiment shows that if we decrease saturation of some object in the image, depth information will be perceived farther than the original physical location.

This experiment was so exhaustive, we reduce test image set for colors as $i=3, j=1\sim 5, k=1\sim 5$. Because the change of i does not seem to have much influence on the test. Therefore, 25 test images were generated for 6 colors as shown in Table 2. The similar result was obtained as in Table 1.

Tab.2 The matched depth index for the change of saturation values(k values)

Reference Color / Saturation	j=1 (92%)	j=2 (84%)	j=3 (76%)	j=4 (68%)	j=5 (60%)
Red	2.5	2.5	2.5	2.0	2.0
Green	2.0	2.5	2.5	2.5	2.0
Blue	2.0	2.0	2.0	2.5	2.5
Cyan	2.5	2.0	2.5	2.0	2.5
Magenta	3.0	2.5	2.5	2.5	2.0
Yellow	2.5	2.5	2.0	2.0	2.0

5. Summaries

In this paper, the method for finding relationship between the change of saturation values and perceived depth information was proposed. By the proposed method, we found if we decrease saturation values for some object in the scene, it looks like more farther than its real location. This fact can be utilized in reducing the viewing fatigue for 3D stereoscopic images because reduce in saturation values to some extent causes the change of perceived depth information without any distortion in depth. Therefore, the viewing fatigue can be controlled in some extent without distortion of depth information.

6. Acknowledgments

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7. References

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