Digital Zoom based on HCI Color Model (Hue-Chroma-Intensity)

Seung Hwan Lee[1], **Dong Hwan Koh**[1], **and Hoon Kang**[1]
[1]School of Electrical and Electronic Engineering, Chung-Ang University, Seoul, Korea

Abstract *- In this paper, we introduce and propose a new color representation scheme, the HCI color model, and a digital zoom method based on this model. The HCI color model consists of three channels; hue, chroma, and intensity. Since this color model is modified from the cylindrical form, not only the problem of saturation dependence on the brightness but also that of fully saturated achromatic color could be avoided. To prove the usefulness and the validity of the HCI color model, several experiments and analysis of the results are presented and demonstrated. Moreover, we applied this model to a digital-zoom interpolation algorithm, and typical mosaic phenomena are reduced by adopting the flood-fill mean shift and B-spline snake algorithm.*

Keywords: hue-chroma-intensity (HCI), color model, image segmentation, digital zoom, computer vision

1 Introduction

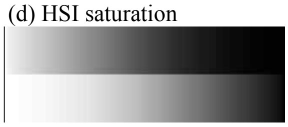
Whenever we describe some objects, we usually explain the native colors or the particular shapes, and leave out the presence of illumination effects such as shadows, shades, and highlights. Needless to say, illumination effects sometimes offer additional information, for instance, the depth of 3D objects or the position of light sources. However, with many algorithms in computer vision, some incorrect results could be readily obtained because of these illumination effects. Careful considerations about lighting are required in a lot of applications and some artificial conditions are often necessary. But this artificial restriction only limits itself. Therefore, if we are able to know the native colors independent of illumination changes, it is more advantageous to extraction or recognition of the target objects.

2 Issues in HSV and HSL Color Models

To demonstrate the unsuitability of the cylindrically shaped spaces for image processing and analysis, we use a synthetic image, which might well reveal the characteristics of each color models, as shown in Fig. 1. The saturation images are extracted from the converted input synthetic image (a) with respect to each color model.

(a) Input image (b) HCI chroma

(c) HSV saturation (d) HSI saturation



(e) HSL saturation (f) IHSL saturation

Fig. 1. Saturations of 3D-polar coordinate color models

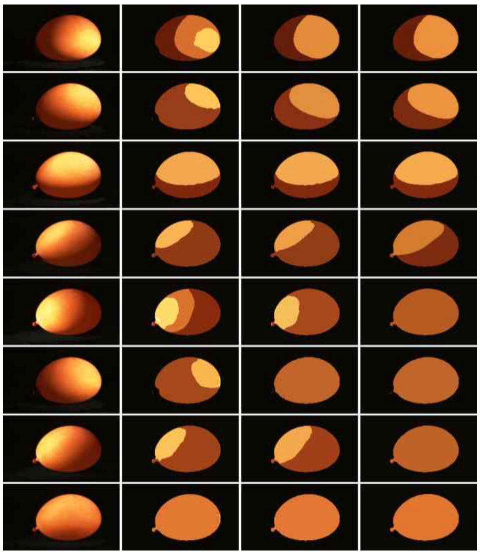
The expansion of the HSV cone into a cylinder results in these pixels getting artificially higher saturation values. Therefore, we may at times face unreasonable situations where some pixels in a dark region are more highly saturated than those in colorful regions that they surround.
We are able to overcome the above problems if the new HCI color model with the real saturation, the chroma, is used instead of the expanded saturation models.

3 Implementation

To demonstrate the usefulness of the HCI color model, we compare the HCI color model with other well-known color models such as, HSV, HSL, IHSL, HSI and so on.
The matching criteria can be calculated by the difference between the reference mask images from the ALOI (Amsterdam Library of Object Image) database and the derived mask images from our segmentation algorithm (Flood Fill Mean Shift). If the mask images, included in the ALOI database, could exactly distinguish an object from the background, then the subset of these mask images is the correct answer to the segmentation problem. Therefore, the rate of difference, i.e. the matching accuracy, is regarded as the objective and quantitative evaluation method.

3.1 Experimental Results

Fig. 2 also shows comparisons among the result images of an orange balloon. The material of this object is a rubber. Since there is no bent or shiny part, the color is changed gradationally. The segmentation output images show more exact results than the other cases. However, there is some influence of the highlights on the directly illuminated area and some effects of the shades on the opposite area. The right-most four result images of the HCI color model from the bottom row, show almost perfect segmentation.



(a) Input (b) RGB (c) HISL (d) HCI

Fig. 2. Result images using various color models; a balloon

When we investigate these result images, the HCI color model is one of the most robust color models against the highlights and the shades among adopted color models. Table 1 shows the comparisons of the matching criteria of the color models.

TABLE 1 MATCHING CRITERIA COMPARISONS OF THE COLOR MODELS

	Matching Criteria			
	Average	Std. Dev.	Maximum	Minimum
RGB	93.51	4.64	99.75	27.85
HSV	94.00	5.75	99.53	65.39
HSL	88.16	12.87	99.77	25.77
IHSL	94.27	4.39	99.68	76.66
HSI	88.39	14.06	99.59	21.61
HCI	94.53	4.15	99.84	79.66

* 'Std. Dev.' is a standard deviation.

4 Digital Zoom

First, creates expanding the image area a group by image segmentation. For maintaining prior form, make control points of B-Spline Snake at a boundary of the segment. Second, using coordinate transformation technique of the active contour with state of relations, the approach of gently filling to maintain the form at digital zoom extension is adopted for absence of information on the border.

4.1 Robust segmentation against the highlights and the shades

If the boundaries of shadows are consecutive, the boundary between shadows and dark visible objects is very difficult to identify. However, the present boundaries of the slope can be recovered its original color by using the Mean Shift algorithm. RGB images are converted to the HCI images in preprocessing. For image segmentation having the characteristics of the constant about shadows, intensity (H) values are most important and standard intensity values can also calculate values for the other elements. First, it calculates the histogram and need to improve the convergence rate for Blurring. And, by using the histogram mode, it finds the values. The calculated values will be Standard H, C, I and all values by using the Mean Shift algorithm are calculated repeatedly. All input data points in the process of mapping is moved the closest standard value. As the last step, HCI color model is converted to the RGB color model. The following figure is a flow chart for image segmentation.

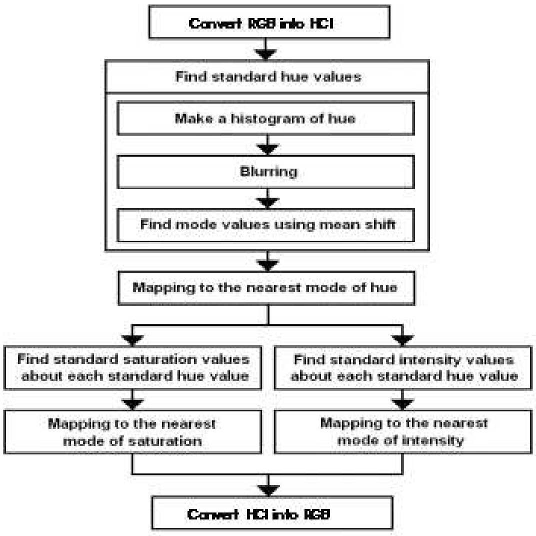
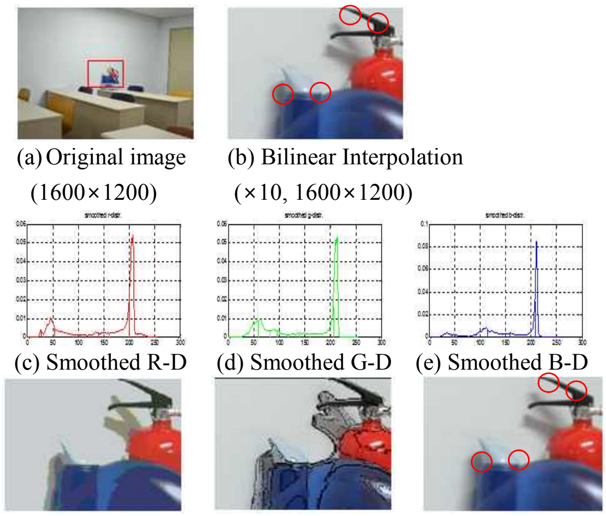


Fig. 3. The flow of Segmentation algorithm for robust to shadows and highlights

4.2 Digital Zoom Simulation



(a) Original image (1600×1200) (b) Bilinear Interpolation (×10, 1600×1200)

(c) Smoothed R-D (d) Smoothed G-D (e) Smoothed B-D

(f) Segmentation (160x120) (g) B-Spline Snake (h) Result (×10, 1600×1200)

Fig. 4. Results robust image segmentation based on light and digital zoom results. (×10 : 160×120 ⇒ 1600×1200)

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MEST) (No. 2011 -0015976).