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The Impact of Color Space and Intensity Normalization to Face Detection Performance

I Nyoman Gede Arya Astawa*[1], I Ketut Gede Darma Putra[2], I Made Sudarma[3], Rukmi Sari Hartati[4]
[1]Programed of Engineering Science, Faculty of Engineering, Udayana University Bukit Jimbaran, Badung, Bali, Indonesia
[1]Department of Electrical Engineering, Politeknik Negeri Bali, Indonesia
[2]Information Technology, Faculty of Engineering, Udayana University, Indonesia
[3,4]Electrical Engineering, Faculty of Engineering, Udayana University, Indonesia
*Corresponding author, e-mail: arya_kmg@pnb.ac.id

Abstract

In this study, human face detection have been widely conducted and it is still interesting to be research. In this research, strong impact of color space for face i.e., many and multi faces detection by using YIQ, YCbCr, HSV, HSL, CIELAB, and CIELUV are proposed. In this experiment, intensity normality method in one of the color space channel and tested the faces using Android based have been developed. The faces multi image datasets came from social media, mobile phone and digital camera. In this experiment, the color space YCbCr percentage value with the image initial value detection before processing are 67.15%, 75.00%, and 64.58% have been reached. Then, after the normalization process are 83.21%, 87.12%, and 80.21% have been increased. Furthermore, this study showed that color space of YCbCr have reached improvement percentage.

Keywords: *intensity, normalization, color, face detection, and android*

1. Introduction

Until now, research on human face detection is still attracting researchers to be investigated. This, because the data growth like images and videos are steadily increasing. Therefore, faces recognizing using face detection features such as skin color is very important(1). Where, the human facial skin has a special color which can be analyzed in the space color including Munsell, RGB, CYM(K), YIQ, YUV, YCbCr, HSI, HSV, HSL, CIEXYZ, CIELUV and CIELAB (2). Where, these methods can be used to detect human faces. In addition, several methods for face detection in color spaces such as YCbCr and HIS [2], color space of HSV using back propagation neural network (3), color space of YCgCr (4), multi features fusion on color space of YCbCr (5), RGB, YCbCr and CIELAB (6), a pornographic image recognition using skin probability and PCA on YCbCr color space (7) have been performed in good accuracy. Where, those study only applied one or two color spaces. Nevertheless, the researchers have not applied all the color space in their research.

Normally, an image consists of some faces, the problem most researchers only detect one face on an image consisting of one face with various methods. However, there are researches detecting many faces or multi faces in an image such as conducted by (8) which is based on eye location and geometrical characteristic of human face by using YCbBr and HIS color spaces. The other problem, most of the researches were done on personal computer (PC) or special device (9). According to (9), mobile phone is no longer a simple device which can only be used for calling, yet it is a mobile computer in which we can listen music, open website, download files simultaneously. Considering the utility of mobile phone as a PC, the researcher implemented face detection system on mobile phone especially in android operation system. Actually, in android system there is face detection system.

The transformation method of color space system is an image processing that conducted in order to gain various color space from certain color coordinate system. Furthermore, RGB is one of the most implemented color spaces in order to represent digital image data. RGB is the basic color space for most image applications because image

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transformation is not required to be presented on the screen (10). Other color spaces are a color space orienting to the user, such as HSI (*Hue Saturation Intensity*) and YCbCr. HSI color space has some variances such as HSV, HSB and HSL which differ in term of linier and non-linier lightness (10).

There were some problems in determining color space in an image. First, the similarity of human as the object and the image background. Second, the difference of image light condition and video in the recording. Third, sensor characteristic of the image and video recorder (11). From these three factors, there is another factor of detecting faces on the image. Therefore, based these difficulties mentioned above, this research aimed at determining color space that can increase the number of face detection. By the consideration of main difference among people with different color skin is on the intensity rather than the chrominance (12). So, intensity normalization method was implemented on every color space. Through this methid, this research will show the impact of intensity normalization to face detection performance. Our contribution in this research is showing the impact the number of face detection performance using the intensity normalization method on the color space RGB, YIQ, YCbCr, HSV, HSL, CIELAB and CIELUV.

Therefore, this paper will apply two models, namely impact of color space and intensity normalization that have been developed to face image detection. Section 2 describes the architectures of color space and intensity normalization models. Section 3 describes the analysis and discussion of the results. Finally, conclusions are summarized in Section 4.

2. Research Method

In this research, face detection improvement have four steps, consist, first, multi faces image is used with RGB color space, and then multi faces detection of the image is prepared. Second, converting image into other color space (YCbCr or YIQ or CIELAB or CIELUV or HSV or HSL) is formatted. Third, the new formatted image in its one channel is added by using intensity normality method. The last, these three channels in color space are regrouped and converted into RGB color space. The system flow chart can be seen in Figure 1.

2.1. Image Data

In this study, 51 face images have been used and tested. The images (i.e., many faces) dataset were social media, mobile phone, and digital camera multifaces were gathered.

2.2. Color Space

In this study, the input images were images with RGB color space. Further, the images YIQ, YCbCr, HSV, HSL, CIELAB or CIELUV color space were converted. The most frequent and well-known color space was RGB (13). RGB (*Red, Green, Blue*) color space as described in (10) have been considered as the basic color space for most of picture application because the gained images do not need to be transformed further to be presented on the screen (10). Representing RGB color space as a cube. Coordinate (0,0,0) is black and coordinate (1,1,1) is white and in score range [0,1]. Grey-scale is in the diagonal line of the cube.

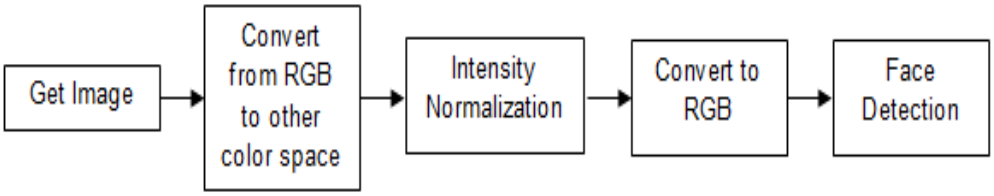


Figure 1. Face Detection of System Flow

Then, RGB color model is classified into two kinds based on its (2); Linear RGB color space, and Non-linear RGB color space (14). YIQ color space is a color space standard in American television in 1950s by National Television Standard Committee (NTSC) (10). YCbCr

color space is mostly used in digital video format such as MPEG format (10, 15). In this experiment, the Y-score in YCbCr was used a luminance scale in this color space.

Then, HSL (*Lightness*), HSV (*Value*), HCI (*Intensity*) are perception color space which most of them are stated as non-linear combination from RGB scores (16). H-value shows Hue which measures the color purity, S shows saturation, and L shows lightness (10). HSL gives high color values for the color approaching white with limited saturation (2). Later, CIELab is one of color spaces defined by CIE (Commicion International de l'Eclairage/The International Commission on Illumination) in 1976 (17). CIE-LAB color space is a color space designed to approach human vision (18). L is a coordinate of an object which is highly appropriate to correct intensity, L is measured in range score 0-100, 0 represents black and 100 represents white (19).

2.3. Intensity Normalization

In this study, the converted image into color space, then in one of the channels have added with intensity normalization method. The added channel is luminance channel in every color space. Intensity normalization method on image is used to decrease the light pluralism on an image (20). The formula of intensity normalization is the same as used by (21) in the research. The formula can be seen in the following equation 1 and 2.

$$I'(x,y) = \begin{cases} \phi_d + \lambda, if\ I(x,y) > \phi \\ \phi_d - \lambda, otherwise \end{cases} \quad (1)$$

$$\gamma = \sqrt{\frac{\rho_d\{I(x,y)-\phi\}^2}{\rho}} \quad (2)$$

Here, I and I' respectively state image before and after normalization, ϕ and ρ state mean score and variance score of the image, ϕ_d and ρ_d are the expected mean score and variance score (21). In this research ϕ_d =100 and ρ_d =100 in all experiments.

2.4. RGB Convertion

In this research, the previous result and after the image was processed by using intensity normalization method. Normalization process was processed after RGB was converted into color space. Every processed image would be converted into RGB color space. This conversion step should be conducted so the next step, face detection could be done.

2.5. Face Detection

Face detection is very important in face recognition. Many face detection methods have been proposed such as (4-6, 8), while in this research for the easiness and efficiency, used face detection facility owned by Android namely OpenCV. To increase the number of face detection in this research, it was proposed additional intensity normalization method in one of the channels in every color spaces such as Y channel in YCbCr and YIQ, L channel in HSL, V channel in HSV, and L channel in CIELUV and CIELAB.

3. Results and Analysis

In this research, there were 51 images used in form of multi face images came from social media, hand phone, and digital camera respectively 17 images from each. As for, the device used in this research was android based Samsung Galaxi tab. Example of the detected faces can be seen in Figure 2.

The experiment process have been settled in Figure 2. Then, the detected face images based on color space results by 51 multi faces images datasets can be seen in Table 1. Table 1 shows that there is additional face detection after the process. Meanwhile, face detection after normalization can be seen in Figure 2.

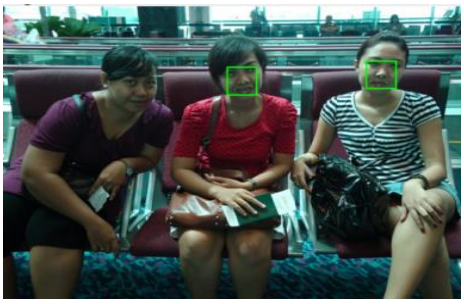


Figure 2. Example of Face Detection on an Image

Table 1 Example of Face Detection Result Based on Color Space

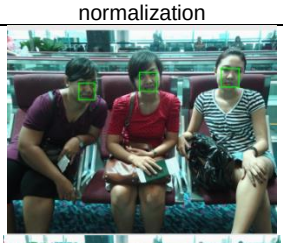
Color space	Result of Conversion	Result of Conversion + intensity normalization	Result of RGB + intensity normalization
YCbCr			
HSL			
HSV			
CIELUV			
CIELAB			
YIQ			

Table 1 Example of Face Detection Result Based on Color Space

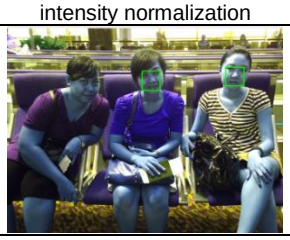
Color space	Result of Conversion	Result of Conversion + intensity normalization	Result of RGB + intensity normalization
RGB			

Table 2. The Result of Face Detection in Color Space

No	Device	Image Number	Number of faces on the image	Number of faces in first detection	Number of detected faces after the process of normalization in color space						
					YCbCr	HSL	HSV	CIE-LUV	CIE-LAB	YIQ	RGB
1	Social media	17	137	92	114	113	111	106	109	111	111
2	Mobile phone	17	132	99	115	113	108	109	111	111	111
3	Camera Digital	17	96	62	77	71	72	74	76	77	74
	All device	51	365	253	306	297	291	289	296	299	296

In this experiment, 17 images or 132 faces from mobile phone were captured, Table 2. Then, number of the detected faces in the beginning were 99 faces. Afterward, every image was converted into different color space and processed by using intensity normalization. After this process, the image was further converted into RGB format and proceeded to redetection of the face. The result was the increase of face detection. In Table 2 for the mobile phone it was found that YCbCr color spaces reached the highest face detection number in total 115 faces. YcbCr color space can be increase of face detection (5-8), although used be different methods.

There was increasing of face detection number from before and after the process in every color space. For instance, the detected face percentage in the beginning in the source of social media was 75%. It was increasing until 87.12% in YCbCr color space. Graph of percentage increase in face detection can be seen in the following Figure 3.

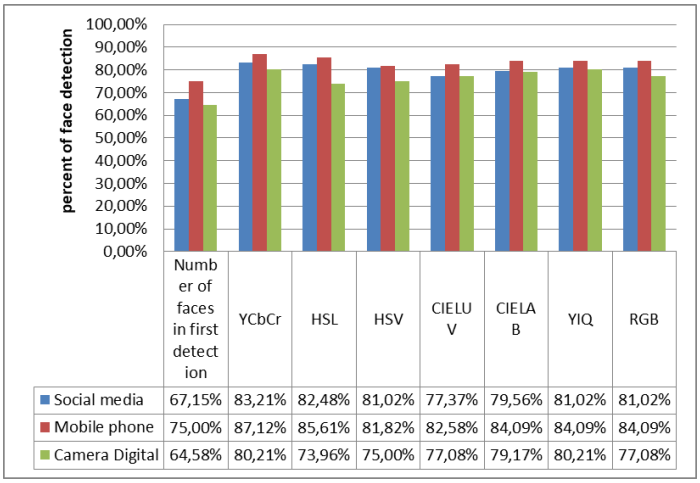


Figure 3. Graphic of Detected Face Percentage in Color Space

4. Conclusion

The image process in color space by adding intensity normalization method have been affected the improvement of face detection performance. Based on experiments, YCbCr color space reached the highest improvement percentage score. The score of detection in the

beginning before the process from social media, mobile phone, and digital camera were 67.15%, 75.00%, and 64.58% respectively with mean score for all devices was 69.32%. Percentage score in YCbCr color space was respectively increasing to be 83.21%, 87.12%, and 80.21% with mean score of all devices was 83.84%. Furthermore, the future works include a comparison of a few face detection methods and the optimization process in order to obtain more detection image performance results.

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