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FINDING OPTIMIZED THRESHOLD FOR SKIN DETECTION IN PORTRAIT IMAGES

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Many methods of skin color detection create a model of skin color and assigned a value between zero and one to each pixel. Those methods needs a threshold for classify skin and non-skin. In this paper, we presented an approach for finding the optimal threshold per image in the portrait images. The results of the proposed method show a meaningful improvement of detect skin against use constant threshold for all images.

Keywords: Artificial intelligence, image processing, skin detection, multilayer neural networks, optimal threshold.

Since many skin color model and many strategies for the detection of skin color in images is presented. This method can be divided into two general categories: pixel based and region based.

Many of methods create a model of skin color and compare each pixel with skin model. These methods needs a Threshold for classify pixels to skin and Non-skin from results of the model. This parameter used as a tool to create a balance between TP and FP. But a Threshold for all images will reduce efficiency and accuracy of the system. Our paper proposes a mechanism to detect the optimum Threshold for each portrait image so that we have the highest accuracy and the lowest FP.

Depending on the training set and the images in it some color range may be less than the others and therefore the skin probability of the pixels with these colors be less. For example, Colored People images is also the case and because there are fewer in training set their skin pixels have less Resemblance to the skin, and with a typical threshold many of their pixels will be diagnosed non-skin. In contrast, people with blond hair need higher Threshold because their hair would not be detected as skin.

To achieve this objective, our proposal is that Start with a Threshold, for example, 0.162 (data set images Best threshold Average), segment skin like image then calculate rate of skin pixels in proportion to the image pixels. We argue that if this average was down it means threshold should be low, and if it was up means threshold should be high. At the end we used the extracted feature for training a multilayer neural network MLP (2) that its objective function is optimize Threshold calculated for every pixel. Mentioned Property calculated on Based (1).

$$mean_{skin_\theta} = \frac{\#skin_\theta = 1}{x * y}, T_{Final} = MLP(mean_{skin_\theta}) * \alpha \quad (1)$$

$$0 < T_{Final} < 1, 0 < \alpha < \infty \quad (2)$$

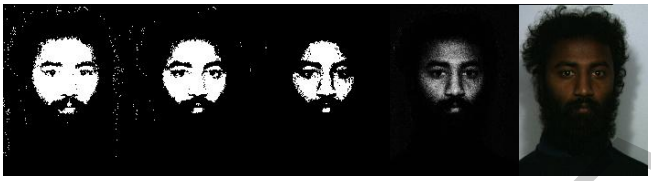
Is number of image skin pixels detected in Threshold θ. x, y is the length and width of the image. T_Final is the system final and optimize threshold for the desired image. α is Added parameter as a tool to balance the detection accuracy and the FP. there is not limit for increased α, but T_Final shouldn't be greater than one.

Here we used a three-dimensional histogram model for model skin color and for better decisions should use the skin and non-skin histogram (3).

$$P_{final} - \frac{P(rgb|sktn)}{P(rgb|sktn) + P(rgb|\sim sktn)} \quad (3)$$

The data set includes 336 images and its guide images that 50 images were used for testing. The results with the best Threshold 0.162 (best Thresholds mean per picture) show 0.0757 difference with optimal Threshold. But with proposed method, the error is reduced to 0.0572.

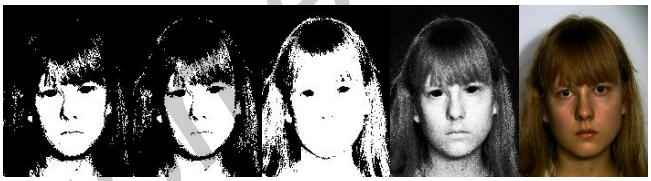
As you can see the results in Fig. 1 picture (*b*) brightness is low because the chances of skin pixels - is low. So with average threshold (Fig. 1, *c*) pixel around the nose are recognized Non-skin. The shortcoming of the proposed method is less (Fig 1, *d*). In Fig. 1, *j* best Threshold used that have lowest rate or percentage of FP but the number of the FP in it is higher than proposed method that is visible of white dots on the hair.



a *b* *c* *d* *j*

Fig. 1. From right to left: *a* – the original image; *b* – Skin like image; *c* – Segmented with average Threshold = 0.162; *d* – calculated with solution Threshold = 0.07; *j* – calculated with optimal Threshold = 0.05

In Fig. 2 (*b*) be see a person with blond hair that her hair color is similar to skin color and with average threshold many of hair pixels detected as skin. But with proposed method has decreased the amount of FP and less hair detected as skin and the result is closer to optimal result. Result of three methods of threshold selection are shown in Table 1.



a *b* *c* *d* *j*

Fig. 2. From right to left: a – the original image; *b* – the skin like image; *c* – Segmented with Average Threshold = 0.162; *d* – calculated with solution Threshold = 0.4; *j* – calculated with optimal Threshold = 0.48

Table 1. Error rates

	Average threshold	*Proposed method*	*Best threshold*
FP Rate	*11%*	*10%*	*9%*
FN Rate	*19%*	*18%*	*16%*

As seen in Tab. 1, Best Threshold also has an error that this caused pixel base approaches inability to complete separation between skin and non-skin pixels with reasons mentioned in the introduction. The results show a reduction of the distance between thresholds was proposed and optimized threshold So that this distance was reduced from 0.0757 for best average threshold to 0.0572 in proposed method. The results in Table 1 show improved detection of skin pixels too. The purpose of this method is only portrait images that can developed it on multiplayer screenshots as future work. For example, with face detection, make ROI and use of a several threshold in an image to improve the performance of the pixel based methods.