Research on Intelligent Selection of Gamut Mapping

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Abstract

Color management based on ICC offers four gamut mappings, an image chooses different gamut mapping to output, and then its color reproduction effects are very different. Therefore the correct choice of gamut mapping is the premise of color management. This article proposes an image classification method--"subjective judgments combine with objective histogram statistics". First of all, experimental images are scientifically classified, then the same kind of image with different gamut mappings is compared, at last the decision tree of selecting intellectually gamut mapping is obtained. And the correctness of the decision tree is verified by subjective evaluation method. By researching on the interrelation between scientific classification of original images and four gamut mappings, this paper provides theoretical basis for intellectual color management.

1 Domestic and foreign situation[1]

Color management based on ICC has played a more and more important role in the application of media colors' correct display and reproduction, and it has ensured the correct transmission of color information between different media. Since the combination and distribution rules of the delivering image's color information are diverse, and the showing-color ability differences of input and output devices are quite big, ICC color management offers four rendering intents,①perceptual matching; ②absolute colorimetric matching; ③relative colorimetric matching; ④saturation matching. The four rendering intents tell different graphic images how to achieve correct reproduction by different input and output devices. But in terms of the domestic situation, the majority of the employees are hard to choose one of the rendering intents to output with the ever-changing images. Therefore, the intelligent selection of gamut mapping is now the primary technology research work.

It is based on the above analysis that we use the technique in artificial intelligence search methods- state space search strategy, namely to use depth-first search method to make image scientific classification model, to find the relevant relations between the original image and four rendering intents, and eventually obtain the decision tree of intelligent selection gamut mapping, so as to provide basic gist for the domestic practitioners to operate intellectually on color management.

2 Experiments[2]

The basic idea of depth-first search is: the initial node S is firstly determined, and then one of its subsequent nodes is selected for inspection. If not a target node, expand and search the others in the same way, to continue the searching. While arriving at a node neither target node nor expanded one, we just choose its brother node to inspect. We store unexpanded nodes in a table called OPEN and expand node in a table called CLOSED. Based on this idea, experiment 1 realizes automatic access of image classification by using computer hardware and software.

2.1 Experiment of building image classification model

Printing images represent outline by tone and level, and tone is the important parameter of determining image types and also the mental physical quantity of measuring people's feelings on overall image shading contrasts and cascade changes. Levels are the units which make up image tones，and every level arranges to form the image tone, so we could obtain the basic classification standard according to the image's main tone.

First of all, we located image tone type by eyes, and then watched images pixel level distribution by gray distribution in PS, and recorded images' average value, median value, color gamut in the composite channel. The integrated observation results of several images showed that the same tone image whose average value, median value, main color gamut information distributed in the same range though images were different. Then the searching process diagram of the image tone according to above experimental analysis is made.

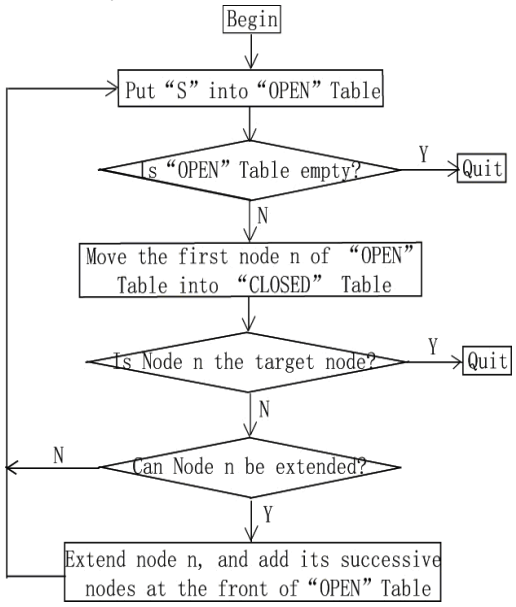


Figure 1 Image tone search process chart

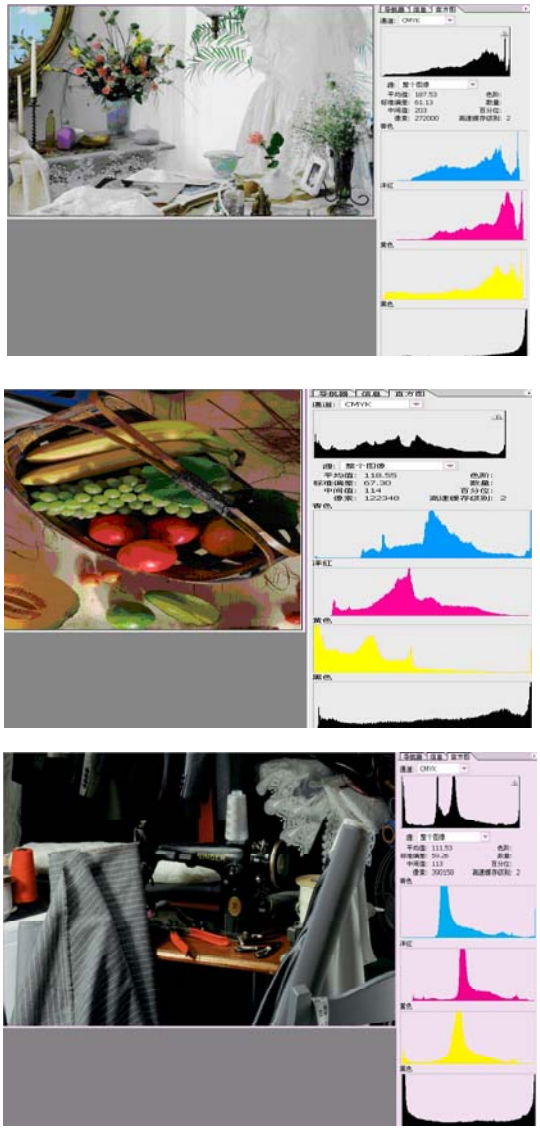
Figure 1 show that we inspect image tone as an initial node S, and then store the node in a table called OPEN, and judge the table if empty. If empty, then exit without solution, otherwise shift the first node "average value" to the table called CLOSED, inspect "average node" whether a target node, if it is then exit, otherwise inspect the brother nodes' "median value", the same to others, then

the last is the node “main color gamut”, so we achieve the image tone classification by the three node judgment.

Through the model, we can get dark-tone image is average value(<80), media value(<80), the main color gamut of distribution (0-75), median-tone image is average value(80-120),median value(80-120),the main color gamut of distribution (75-165), high-tone image is average value (> 120), median value(> 120), the main color gamut of distribution (165-225). The image which exits without solution is whole-tone one.

2.2 Image reduction effects comparison experiment[3]

Choose five standard images: wedding image, fruits image, room image, sewing room image, character image according to the image classification, open them in PhotoShop and show in figure 2:



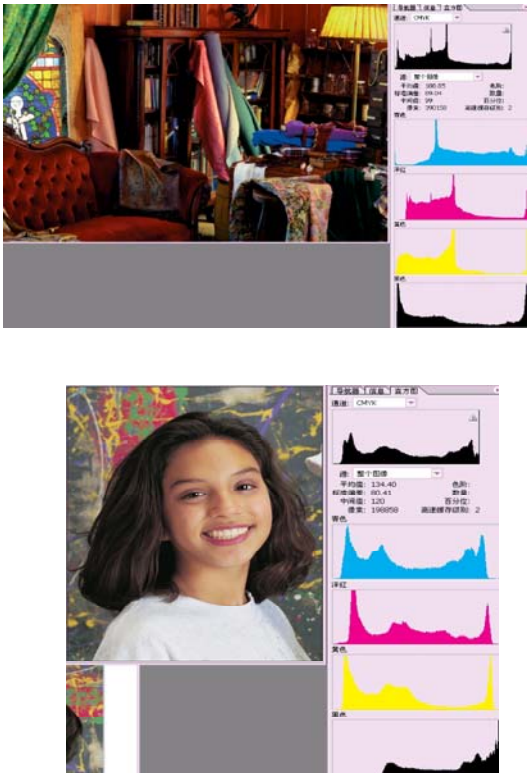


Figure 2: standard image—wedding, fruits, room, sewing room, character

By using standard light source D50 observation conditions, HP 130 and EFI Color Proof digital proofing process, we output images with different rendering intents and compare the characteristics color between output image and original image in table 1:(a—wedding, b—fruit, c—sewing shop, d—room, e—girl)

Table 1: Comparison of the characteristics color between output image and original image

output intent / image		perceptual matching①	saturation matching ②
a	White (such as candle) yellow	slight yellow, and yellow with green	slight yellow, and yellow with green
	green leaves	more green	more green and most saturated
	red flower	more red	more red
b	backgrou-nd	yellow	more yellow
	green leaves	more green, level seriously losses	more green, level seriously losses
	Cherries	too red, level losses less than②	most red，level lest losses

	banana	light red, tail is red	light red, tail is most red
c	clothing	seriously partial color with cyan	the same to ① and lest level
	spool	too red	too red and more colorful
d		seriously partial color，more colorful，especially lamps, but better than ②	seriously partial color，especia lly sofa and lamp mostcolorful，great contrast
e	hair	black with red	black with red，more saturated than ①
	face	red，less than ②	right cheeks most red

image \ output intent		relative colorimetric matching③	absolute colorimetric matching④
a	white (such as candle), yellow	slight yellow, and yellow with green, most bright	slight yellow, and yellow with green
	green leaves	more green	more green
	red flower	more red	more red
b	backgro -und	yellow	yellow
	green leaves	more green, level less losses	more green, level less losses
	cherries	saturation less than ① and ②, level less losses	saturation less than ① and ②, level less losses
	banana	light cyan，tail is not too red	light cyan，tail is not too red
c	clothing	seriously partial color with cyan	seriously partial color with cyan
	spool	saturation less than ① and ②	saturation less than ① and ②
d		seriously partial color，more colorful，level better than ① and ②，most bright	seriously partial color，more colorful，level better than ① and ②
e	hair	black with cyan	black with cyan, more black than ③
	face	skin is not rosy，most bright	better than③

We can see that saturation matching is not suitable for precise color matching and image proofing output, but saturation matching more fit for graphics, tables, maps output in actual production.

3 Analysis of the experimental results

We use the same search algorithm in the latter experiment with above experiment analysis, that is, list reproduction targets of the images which need to be analyzed and select a node to inspect in the following nodes, then successfully exit if achieve the target node search, otherwise will obtain subordinate node according to the relation of target gamut and image gamut. We finish the analysis process of selection gamut by the image tone character from original image classification model.

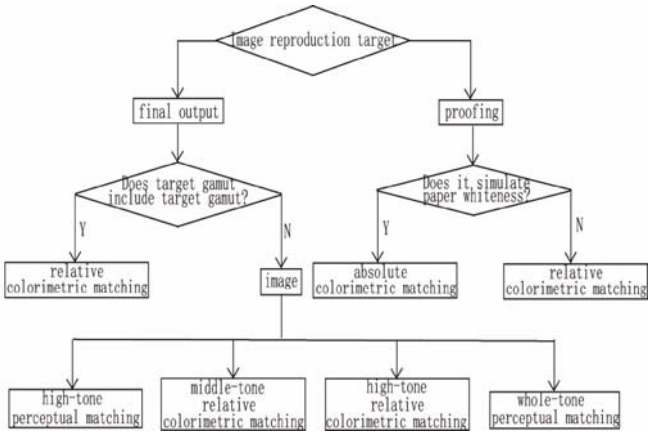


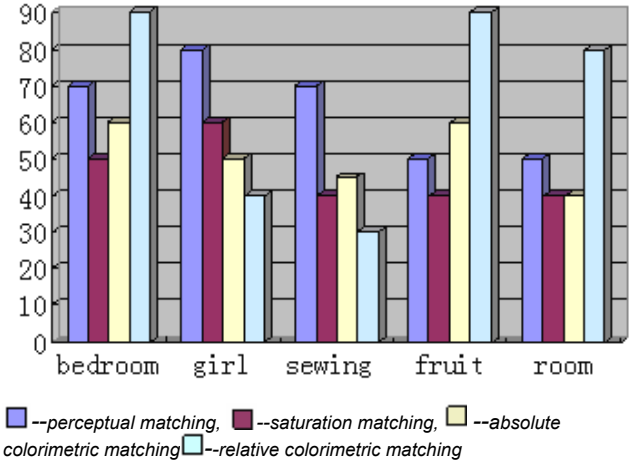
Figure 3: the decision tree of intelligent selection of gamut mapping

We obtain figure 3 by the above algorithm and comprehensive judgment in the form of decision tree.

From the decision tree, we can see that the three elements: image character, target gamut and image reproduction target have consequently influenced the rendering intent choice. When the target gamut is more than image gamut, the relative matching should be used for reproduction. However in actual production the target gamut is less than image target, so the dark tone image should choose perceptual matching, middle tone image and high tone image should choose relative colorimetric matching, whole tone image should choose perceptual matching for reproduction. Usually we select relative colorimetric matching when the source gamut is almost equal with target gamut. Only when the proofing device gamut is big enough to include the final output device gamut can the proofing target be realized in image reproduction. So perceptual matching and saturation matching are not fit for proofing, while saturation matching is fit for graphic and map output. For proofing process, if proofing simulates paper whiteness in actual printing we choose absolute colorimetric matching, or choose relative colorimetric matching.

4 Experiment results verification

Select 50 visual observers to take part in visual evaluation experiments, then observers' judge results are as follows:



Combining with histogram, we found that selecting relative colorimetric matching and perceptual matching are the most and reflected that in the decision tree.

The standard test images about selection rendering intents from the figure are in concordance with the decision tree, so verify the decision tree correctness again. But differences of personal subject factors also exist, so the decision tree offers an intelligent rendering intent selection which closes to original image and precludes personal subjective factors.

References

[1].ICC: ICC Profile Format Specification Version 4.0.0(2001-12)

[2]. George F. Luger .Artificial Intelligence Structures and Strategies for Complex Problem Solving.

[3]. Fairchild M D. Color Appearance Models [M]. Reading, USA: Massachusetts 01867, 1997, 215—217.