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Analysis on Color Extraction of Daur Traditional Craftwork Based on Fuzzy Clustering Algorithm

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Abstract

In this paper, the disappearing daur culture and its color of traditional craftwork are surveyed and classified. By reviewing the relevant literature and video data, the RGB color module of single utensil and visual recognition image are selected to represent the pattern of this craftwork of daur. Specially, color quantization is achieved by feature extracting for the building of color database based on which a further color message classification is accomplished. Finally, fuzzy clustering is conducted to compute the complexity of color which also verifies its high precision.

Keywords: *Daur, Fuzzy Clustering, Color Information, Precision*

1. Introduction

Fuzzy clustering analysis theory is widely applied to simulate human brain as its good performance. Focus in our work is put on the changing Daur color of traditional craftwork, and fuzzy sets are utilized to describe the color of Daur utensil according to the extracted features for classification. As well, the color of Daur utensil is simulated through states and analyzed via our built criteria and fuzzy system. Based on this, the color features and the uncertain color features are distinguished and compensated after calculating the optimal range of color threshold by clustering considering the fuzzy matrix constructed between similar color features. Thus, a new color system is developed so that the color of Daur utensil can be digitally recovered, restored and protected according to the similarity of color simulated by our brain.

2. Mathematical Model of Fuzzy Clustering Analysis

Let data matrix, $X = \{x_1, x_2, \ldots, x_n\}$ denotes all the objects that will be analyzed, each sample in X, x_i(i =1,2,…,m) denotes the m color features of each object, different color characteristics of each parameter are denoted by value x_i.

$$\begin{bmatrix} x_{11} & x_{12} \ldots & x_{1m} \\ x_{21} & x_{22} \ldots & x_{2m} \\ \vdots & \vdots & \vdots \\ x_{n1} & x_{n2} \ldots & x_{nm} \end{bmatrix}$$

And in which, Xnm denotes the m-th index of raw data in the n-th object of classification. Divide $x_1, x_2, \ldots, x_n$ into several disjoint subsets $X_1, X_2, \ldots, X_c$, according to the affinity relationship among samples, while satifying the following requirements:

$$X_1 \cup X_2 \cup \ldots \cup Xc = X, \quad X_i \cap X_j = \varphi \quad (1 \le i \ne j \le c)$$

The membership relationship between sample $x_k(1 \le k \le n)$ and subset $X_i(1 \le i \le c)$ can be expressed using the membership function as:

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$$\mu_x(x_k) = \mu_{ik} \begin{cases} 1 & x_k \in X_j \\ 0 & x_j \in X_j \end{cases}$$

Here, the membership function should meet the needs of $\mu_{ik} \in Eh$. Which means that each sample can only be attached to one category, and at the same time, each subset (class) should be non-empty.

3. **Steps Cluster Analysis**

Establish the fuzzy similar matrix Rs, similarity coefficient r_{ij} denotes the variables of similarity degree between two samples, the closer to 1 the value r_{ij} is, the more similar they are. The obtained fuzzy matrix R then is transformed into a fuzzy equivalent matrix R1. Using quadratic method to determine the transitive closure of R, define t(R)= R^1. After process from large to small, a dynamic clustering map is formed.

$$\text{Rs}=\begin{bmatrix} r_{11} & r_{12} \dots & r_{1n} \\ r_{21} & r_{22} \dots & r_{2n} \\ \vdots & \vdots & \vdots \\ r_{n1} & r_{n2} \dots & r_{n3} \end{bmatrix} \qquad R^1=\begin{bmatrix} 1 & r_{12} \dots & r_{1n} \\ r_{21} & 1 \dots & r_{2n} \\ \vdots & & \vdots \\ r_{n1} & r_{n2} \dots & 1 \end{bmatrix}$$

So that we can get packets Rs→R^1, fuzzy equivalent matrix, and when value λ changes from 1 to 0, different dynamic clustering results are correspondingly produced: if λ=1, then:

$$\tilde{R} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

The closer value λ is to 1, the more detailed the categories are; the closer value λ is to 0, the more sketchy the categories are.

4. Color Samples Collection

Author names and affiliations are to be centered beneath the title and printed in Times New Roman 12-point, non-boldface type. Multiple authors may be shown in a two or three-column format, with their affiliations below their respective names. Affiliations are centered below each author name, italicized, not bold. Include e-mail addresses if possible. Follow the author information by two blank lines before main text.

4.1. Research Preparation

The extraction of color information need to be obtained in the form of photo shoot or text description depends on different objects, in order to provide basic support for later scientific quantitative description. Specific sample collecting may use photo shoot, physical sample color measuring, contrast with color cards and former records, color analyzing device for testing color values. Choose the color values that have corresponding values on the NCS hue circle, which are also representative and relatively larger area among the color intervals. Use true color image RGB as the color mode, check if the color of object is reduced as consistent as the color control scale. Use RGB to descibe the quantization value of each sample, white (R=255, G=255, B=255) and black (R=0, G=0, B=0) would not be considered as reference. Color collection could only either belong or does not belong to the given range. Conclude the measured referential data, equipments and device include: color stilbmeter (TOPCON BM-7), spectrophotometer (SpectrophotometerCM-2600d), digital camera, color cards.

4.2. Test Environment

Good sunny days with good visibility, avoid glare and backlight color. Time 9:00-11:00 and 13:00-15:00. Test distance must be farther than 350 mm.

4.3. Sample Classification

Table 1. Color Samples of Daur Historical Products

Cultural property	Physical property	Color composition(above 25% hue)	Implement Material
Object	Birch-bark Box	Yellow, White	Birch-bark
Art	Paper-cut	Red, Yellow, Green, Blue, White, Black, Purple	Paper, Animal skin
Craftwork	Embroidery	Red, Red-yellow, Green, Green-blue, Blue, Black, Blue-purple, White, Yellow	Fur, Silk
Craftwork	Leather-making	White, Blue	Fur
Religion	Modeling	Blue, Green, Red, White, Black, Yellow	Paper, Cloth, Tinsel
Religion	Sculpture	Yellow, Yellow-green	Wood block, Tree bark
Religion	Sacred Drummer	Yellow, Red, Yellow-red, Blue	Leather, Wood
Fence	Knitting	Yellow, Yellow-red	Willow twig
Craftwork	Casting	Yellow-red, White, Yellow	Gold, Silver, bronze

4.4. Contrast of Color Cards

Record different values of the measured color samples into database (Ostwald Color Solid). Compare the color-coded and color card numerically on the basis of the contrast between instrument test and eye measure, then to select the comparative results under the principle of value closest, finally get the standard color of Daur utensil culture.

4.5. Color Information Extraction

Using the NCS Hue Cricle (natural color system), based on six psychological primary colors, white, black, red, yellow, green, and blue theme color sensations, divided into colors: yellow, yellow-red, red, red purple, purple, purple-blue, blue, blue-green, green, and green-yellow, which is totally 10 categories, including yellow, red, purple, blue and green as the base colors; yellow-red, red-purple, purple-blue, blue-green, and green-yellow as the intermediate hues between two adjacent base colors (Figure 1).

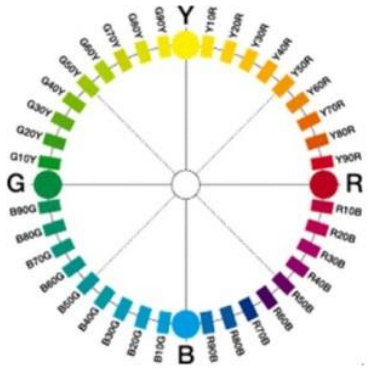

Figure 1. NCS Hue Circle

The R, G, B values in color database describe the quantization value of each pixel, the closer two sets of R, G, B value, the more similar color the pixels represent. The grouping span of pixel color lies in the range of integers between 0 to 255, adopt with the value λ[0, 1], make the integers between 0 to 255 divided by 255 and convert them to a range of values that between 0 to 1.

R=Sum of value R in pixel image \Sum of all pixels
G= Sum of value G in pixel image \ Sum of all pixels
B= Sum of value B in pixel image \ Sum of all pixels

4.6. Standard Quantization of Color Features

Black and white are considered as non-color in chromatic system, and others are NCS colors. Any NCS color is constituted by three properties, which are hue, brightness and saturation. Hue distinguishes color from others, brightness measures the degree of light and shade in colors, saturation tells the purity level of color, and the NCS color system is composed by these certain rules and orderly arrangement. Hue can be divided into 5 base colors and 5 intermediate colors. These 10 different colors are the basis for the color research, application, specification, and also the foundation of quantifying color features. Concrete steps of classification method is introduced as follows:

(1) From hue value1-64, establish the color-coded data table.
(2) Determine the sample color nouns ' corresponding code in color cards, get the hue value range.
(3) Determine the color proportion of R,G,B by analyzing the frequency of occurrence of hue, brightness, saturation.
(4) Add intermediate colors between base colors, determine 10 hues threshold.

Table 2. Hue and Hue Range

Hue	Hue Range
Yellow	5-11
Orange	11-15
Red	14-23
Pink	17-29
Purple	16-41
Blue	38-56
Green	48-64,1-8

Table 3. Threshold Definition of Ten Hues Interval

Hue	Hue Value Interval
Green-Yellow	When green is adjacent to yellow, the data of the overlap shall be used as the hue range of the intermediate color. The value of the overlap, as known as the value of green-yellow, is 5-6
Yellow	Yellow next to yellow-red means base color is adjacent to intermediate color. The interval definition obeys the greater side. The interval value of yellow is 7-10.

Yellow-Red	Yellow next to red means base color is adjacent to base color. The interval definition obeys the greater side. The interval value of yellow-red is 11-14.
Red	Base color red is adjacent to intermediate color, The interval value of red is 15-18.
Red-Purple	Red-purple next to red means intermediate color is adjacent to base color. The interval value of red-purple is 19-29.
Purple-Blue	Purple and blue are base colors that next to each other. The interval definition obeys the greater side. The interval value of purple-blue is 38-41.
Purple	Base color purple is adjacent to intermediate color. The interval value of purple is 30-37.
Blue-Green	When blue is adjacent to green, the data of the overlap shall be used as the hue range of the intermediate color. The interval value of blue-green is 49-56.
Blue	According to the interval value between purple-blue and blue-green, which determines the interval value of blue is 42-48.
Green	The green interval is between the lower limit of blue-green and the upper limit of green-yellow, which determines the interval value of green is 57-64 & 1-4.

Table 4. Demarcation of Brightness Threshold

Brightness	Brightness Range
High brightness	11-12
Medium-to-high brightness	13-14
Medium brightness	15
Medium-to-low brightness	16-17
Low brightness	18-19

Table 5. Demarcation of Saturation Threshold

Saturation	Saturation Range
Low saturation	0-12
Medium-to-low saturation	13-25
Medium saturation	26-38
Medium-to-high saturation	39-51
High saturation	52-64

4.7. Fuzzy Clustering Samples Match

Color information data characteristicsare set on the basis of thresholds of more sample data, and secondary clustered on the basis of sample color characteristics and colors' own

property. So that semi-automatic extraction of interactive color features are finished according to the principle of maximum matching, and improve the matching pattern constantly.

5. Establish Fuzzy Similar Color Matrix

To cluster sample eigenvalues R, G, B, brightness value V; chroma value S; contrast value C; hue proportion value H; color type red, yellow, green, cyan, blue, magenta; hue contrast value Ht; use data from table 6 as color sample, extract the color feature image of traditional Daur craftwork, create the space of characterized dimension on the basis of the collected data in the integers range of pixel RGB value from 0 to 360.

Figure 2. Color Features of Daur Craftworks

Table 6. Daur Color Craftworks' Feature Dimensions Sample

No.	R	G	B	V	S	C
1	0.47	0.44	0.42	0.47	0.15	0.31
2	0.69	0.62	0.5	0.69	0.27	0.56
3	0.52	0.45	0.34	0.44	0.22	0.45
4	0.57	0.55	0.51	0.56	0.14	0.36
5	0.45	0.34	0.26	0.41	0.4	0.27

Eigenvalue matrix：

PJ=

$$\begin{bmatrix} 0.47 & 0.44 & 0.42 & 0.47 & 0.15 & 0.31 & 0.72 & 0.22 & 0.05 & 0.007 & 0.005 & 0.01 & 0.2 \\ 0.69 & 0.62 & 0.5 & 0.69 & 0.27 & 0.56 & 0.08 & 0.93 & 0.003 & 0.004 & 0.002 & 0.004 & 0.2 \\ 0.52 & 0.45 & 0.34 & 0.44 & 0.22 & 0.45 & 0.08 & 0.71 & 0.06 & 0.07 & 0.06 & 0.03 & 0.2 \\ 0.57 & 0.55 & 0.51 & 0.56 & 0.14 & 0.36 & 0.74 & 0.23 & 0.008 & 0.004 & 0.003 & 0.01 & 0.2 \\ 0.45 & 0.34 & 0.26 & 0.41 & 0.4 & 0.27 & 0.66 & 0.15 & 0.1 & 0.08 & 0.01 & 0.03 & 0.2 \end{bmatrix}$$

5 similar sample eigenvalue matrix were calculated:

$$cArr=\begin{bmatrix} r_{11} & r_{12} & r_{13} & r_{14} & r_{15} \\ r_{21} & r_{22} & r_{23} & r_{24} & r_{25} \\ r_{31} & r_{32} & r_{33} & r_{34} & r_{35} \\ r_{41} & r_{42} & r_{43} & r_{44} & r_{45} \\ r_{51} & r_{52} & r_{53} & r_{54} & r_{55} \end{bmatrix}=\begin{bmatrix} 1 & 0.7724 & 0.7758 & 0.9945 & 0.9599 \\ 0.7724 & 1 & 0.9947 & 0.7898 & 0.7401 \\ 0.7758 & 0.9947 & 1 & 0.7879 & 0.7589 \\ 0.9945 & 0.7898 & 0.7879 & 1 & 0.9463 \\ 0.9599 & 0.7401 & 0.7589 & 0.9463 & 1 \end{bmatrix}$$

From the matrix we can conclude that the similarity of sample 1 and sample 2 is r12=0.7724, and the similarity of sample 1 and sample 4 is r14=0.9945. Since value r14 is closer to 1 than r12, sample 1 is more similar to sample 4. According to the analysis of the

matrix, the threshold of traditional Daur craftwork color sample setting is the premise of the fuzzy clustering matching, carry out the hierarchical clustering on a feature sample and several initial samples, the process combines two desirable samples into a new sample successively via certain clustering criteria. A variety of different information options and modes would come up when the data are being matched, the more the samples correspond to the color mode, the greater the possibility is.

6. Conclusion

According to the experimental data of the fuzzy clustering color, the precision of color extracting and analyzing using this algorithm is proved remarkable. Therefore, color information of more feature samples would be automatically extracted. In order to make a more efficient and complete database, it should be acquired from different artificial view of angles. The threshold of the color information eigenvalue are also set more diversely, as well a new sample data threshold with psychological color characteristic. After achieving the extraction in multiple aspects, the fuzzy clustering is executed iteratively, which not only improves the matching pattern, but also establishes similarity matrix for hypothesis.

7. References

7.1. Book

[1] X. Guo and X. Er, "Daur Relics Catalog", Neimenggu Publisher, Huhehaote (**2008**).
[2] L. Chang, "Quantization of Fashion Color and Prediction Analysis", Jiangnan University Thesis, Wuxi (**2013**).
[3] S. Er, "Ewenki Folk Arts Research", Neimenggu Culture Publisher, Huhehaote (**1997**).
[4] J. Lu, "Daur Traditional Handicraft Research", Neimenggu Agricultural University Thesis, Huhehaote (**2011**).
[5] J. Fan, "Fuzzy Clustering New Algorithm and Clustering Validity Research", Xinan Technology University Thesis, Mianyang (**1998**).
[6] Hualinge, "Daur Soren Source Survey", Qing Dynasty Publisher, Beijing (**1833**).
[7] National Nation Committee, Daur Social History Survey, Neimenggu People Publisher, Huhehaote (**1985**).
[8] B. Shen and J. Gao, "Chinese Daur Population", Neimenggu University Publisher, Huhehaote (**1998**).
[9] Y. Mao and S. Yi, "Daur-Neimenggu Morin Dawa Banner Hadley Village Survey", Yunnan University Publisher, Kunming (**2004**).
[10] L. Tie, "Neimenggu Morin Dawa Nation Autonomous Flag", Neimenggu People Publisher, Huhehaote (**1998**).
[11] S. Song and Z. Bai, "Ethnonymics Theory and Methodology", Central University for Nationalities, Beijing (**1998**).
[12] Z. Meng,"Daur Research", Neimenggu Education Publisher, Huhehaote (**2009**).
[13] Manduertu, "Daur Cyclopedia", Neimenggu Culture Publisher, Huhehaote (**2007**).
[14] Modeertu, Daur Boot Harmory Denhara Family Tree, Neimenggu Culture Publisher, Huhehaote (**2002**).

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